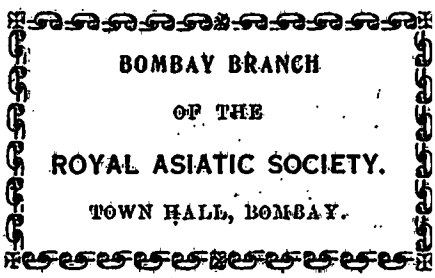
Agriculture and Animal Husbandry in India

1935-36

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PREFACE

It is a heartening and also a sobering thing to look back over the annual reports that have been issued on progress of agricultural science in India since these reports commenced (*i.e.*, 1904). The first workers had an almost untouched field and threw themselves into the task confronting them with eagerness. The early Memoirs of the Department of Agriculture in India in all branches of agricultural and allied sciences indicate how well they chose their problems and how well they did their work. The war was a great interruption, but thereafter progress was again marked. The Royal Commission on Agriculture and its most prominent result, the Imperial Council of Agricultural Research, have helped development and co-ordination. So far as cotton research is concerned, the finance and criticism supplied by the Indian Central Cotton Committee have been invaluable, and there are various other bodies which have helped on the good work in various directions. It is hoped that on the advice that will be contained in the reports of Sir John Russell and Dr. Wright, who have in the past year investigated all the activities of the Imperial Council of Agricultural Research, still better things may be planned and achieved. To estimate the present position, especially in view of these impending reports, is a little difficult, but the following at least can be said.

Agricultural scientists in India are definitely making use of the many important findings of the pure sciences on which their applied work is based. In the realm of plant-breeding, modern genetic theory is being applied in many ways, *e.g.*, in divising a rational system of classification of old and new plant varieties, in the study of the chromosome relationships of wild and cultivated species and their hybrids, in devising ways of multiplying varieties that offer peculiar difficulties in seed-multiplication on account of their being normally cross-fertilised and so on. In soil science, the epoch-making work of the Russians in soil-classification is being applied, and the work done all over the world on colloids is finding its place in our soil-research programmes. It would be possible to give similar examples in every science that has any connection with agriculture. Veterinary research and investigation, animal genetics, animal nutrition and disease control are all now at a level

impossible twenty-five years ago, as much of the fundamental knowledge was then only in the making. Then there is the tremendous advance made in obtaining significance from field and feeding experiments due to the methods worked out by Fisher and others, methods which are now standard on Indian agricultural experiment stations. All these things have made for a greater accuracy, a finer technique and have made possible improvements in directions where in the past we believed we had reached finality. There is no finality. Knowledge grows and grows. So does its application.

But we are far from anything approaching finality in many directions. While much is known empirically about manuring, we are a long way off from understanding the plant physiology that underlies the results we get and the variations in these results. While we know much about many of our insect pests and their life-histories, the practical control of them on a large scale still has a long way to go. While we know a good deal about live-stock breeding and management we are yet far from having an organisation adequate to the task of producing anything like the required number of breeding animals or of making the most of the huge live-stock resources of India for the better nutrition of the people and for maintaining and increasing the return from the land.

Lastly, the technique of " putting across " the results of research to the cultivator has made great strides and now involves many agencies never dreamt of before, but the need for increase in the intensity and volume of such propaganda is more insistent than ever.

The results of the year 1935-36 are now presented. After the publication of Agriculture and Animal Husbandry in India, 1933-34 and 1934-35, the Imperial Council of Agricultural Research decided that the succeeding issues should be annual. This review accordingly deals with the year 1935-36, and is based on the annual reports of the Central, Provincial and State Departments and the Review of Trade in India for the year 1935-36. Some provincial reports deal with the agricultural year ending on 30th June, while the others and the Review of Trade in India deal with the fiscal year ending in March. The statistics quoted in this review, with the exception of those relating to exports and imports, relate to the agricultural year ending on June 30.

The review includes references to all reports received up to 30th June 1937.

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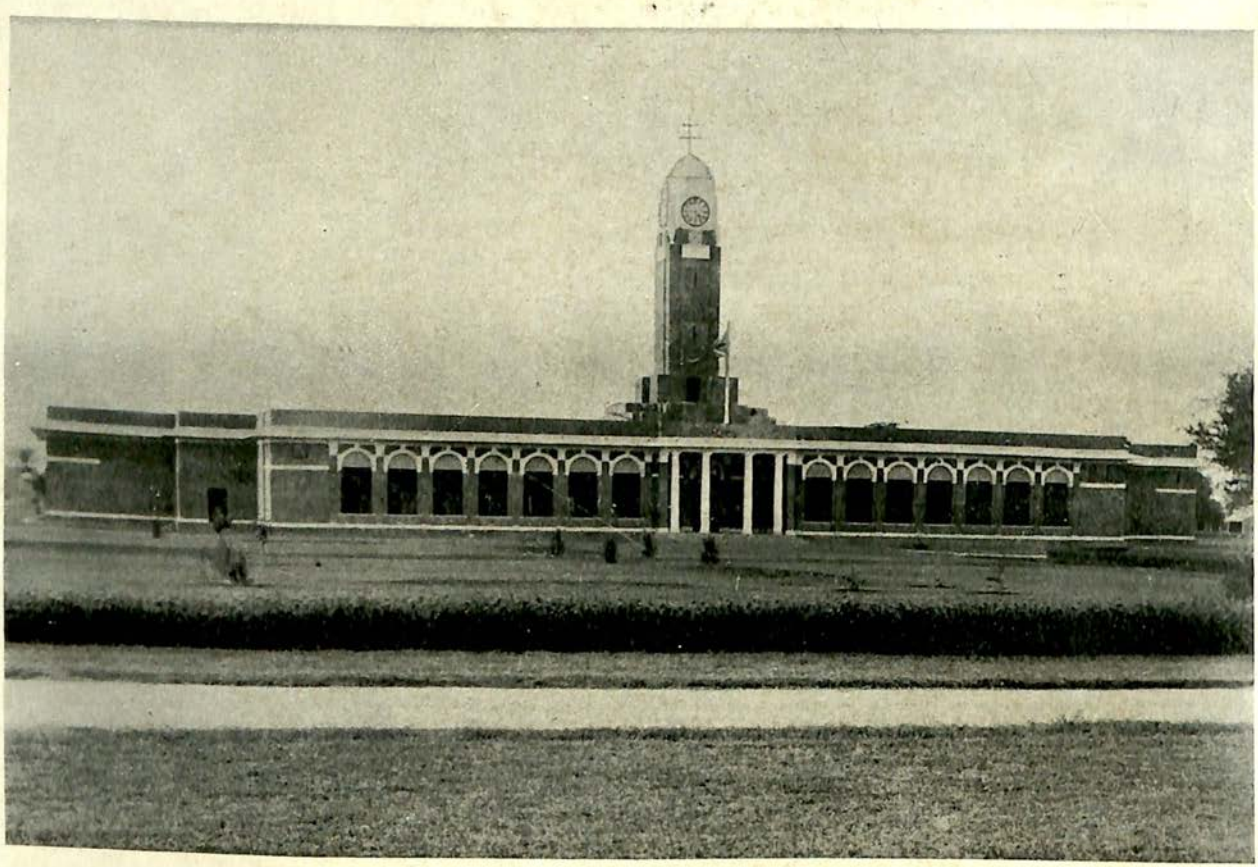
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(*Reproduced from Scientific Reports of the Imperial Agricultural Research Institute, New Delhi, for the year ending June 30, 1936*)

Agriculture and Animal Husbandry in India, 1935-36

CHAPTER I

AGRICULTURAL CONDITIONS DURING 1935-36

1. AGRICULTURAL AND CLIMATIC CONDITIONS

THE monsoon of 1935 was, on the whole, fairly satisfactory. Owing to its uneven distribution, however, the rainfall was defective in some provinces such as Bengal, the United Provinces and the Punjab. During the retreating period of the monsoon, conditions were unusually dry over the greater part of the country. Taking the year as a whole, the rainfall was within twenty per cent of the normal all over the country, except in the north Madras coast where it was defective by twenty-three per cent.

The crop outturns, with a few exceptions, were good. The outturn of rice in India and Burma was eight per cent short of the production in the preceding season owing to unfavourable conditions in Bengal and Bihar and Orissa. Burma, however, realised a good crop and the production there was eleven per cent in excess of that in the preceding season. Increased cultivation of sugarcane accounted for an increase of about fifteen per cent in the estimated *gur* (raw sugar) production as compared with 1934-35. Cotton recorded an increase in outturn of twenty-three per cent as compared with the preceding season. The jute crop was subject to adverse weather conditions and this, combined with the scheme for restricting the output, brought the total outturn down to eighty-five per cent of the 1934 figure. The production of groundnuts, sesamum and castor seed showed considerable increases. The outturn of rape and mustard (winter oil-seeds) declined by five per cent, while that of linseed increased by twelve

per cent as compared with the preceding season. The wheat crop of 1934-35 showed an increase of three per cent over that of the preceding season.

MADRAS. The South-West monsoon started late and weakened in the latter half of September, the rainfall being on the whole normal in East and West Godavari, Kistna, the Deccan, Nellore, Chingleput, the Central districts (Coimbatore excepted), Madura and South Kanara and below normal in the other districts. The North-East monsoon was generally below normal outside South and North Arcot, Bellary, Trichinopoly, Tanjore, Madura, and South Kanara districts.

BOMBAY. From the agricultural standpoint, the year was fairly satisfactory over a large part of the Presidency. The outstanding features of the monsoon were the long breaks during July, August and the latter half of September and the early cessation of the rains. The season was particularly unfavourable for rice. The outturn of *kharif* (rainy season) crops was fairly good over most of the Konkan, the West Deccan and the irrigated areas, fairly satisfactory in Gujarat (except Ahmedabad), the East Deccan and the Karnatak, but somewhat poor in Ahmedabad district. The *rabi* (winter or spring) crops, though poor in Gujarat, were fairly good in the Deccan and the Karnatak.

BENGAL. The year was one of the most difficult for agricultural operations. In March, April and May the rainfall was in deficit throughout the province, resulting in late sowings, particularly on highlands. Though the rains from the middle of May to June facilitated the *kharif* sowings and the preparation of winter-paddy seedbeds, the insufficient rainfall in July and August delayed the transplantation of winter paddy and the prolonged drought from October seriously affected both winter paddy and the *rabi* crops, Western Bengal being affected most. The only crops that had normal outturns were jute and lowland *aus* (autumn) paddy.

UNITED PROVINCES. Though the monsoon broke late, it gave general rainfall throughout the province. There was a deficiency of rain in August which was, however, made up by general and widespread falls in September, after which the monsoon withdrew from

the province. On the whole, the *kharif* season was favourable for sowing but the deficiency of rainfall later had an adverse effect on the standing crops, especially rice. The *rabi* preparations were somewhat handicapped by the short monsoon, but the subsequent weather conditions were favourable for plant growth with the result that the outturn for the *rabi* crops was generally fair.

PUNJAB. During the monsoon period there was sufficient rainfall all over the province which proved beneficial for the *kharif* sowings; but the early cessation of the monsoon and the subsequent dry conditions that prevailed affected the *kharif* crops adversely especially in *barani* (rain-fed) tracts. Though the sowings for *rabi* crops were not altogether normal, the few showers in December helped the growing crops and facilitated further *rabi* sowings and the timely rains in February and March proved generally beneficial. The weather during April and May was favourable for harvesting operations.

BURMA. The season was on the whole favourable to the main rice crop in Lower Burma, though the expectations of a bumper crop were not realized owing to the uneven distribution of the rains. The unusually heavy rains in late October and early November damaged the paddy crop in Mid-Burma. In Upper Burma the season was indifferent for cotton but good for groundnut and sesamum.

BIHAR AND ORISSA. Agriculturally the year was not quite satisfactory, the monsoon rains being insufficient in most places and unevenly distributed generally. While the insufficient rain in June and July delayed sowings of *bhadai* crops (grown and harvested in August to September), the excessive falls in August and September damaged them in Tirhut and Patna divisions. The failure of *hathia* (October) rains and the meagre falls in November and December lowered the outturn of *aghani* (winter) rice and retarded the growth of *rabi* crops.

CENTRAL PROVINCES. There was persistent and heavy rainfall in the early monsoon period which proved unfavourable to *kharif* crops except rice. The abrupt cessation of the monsoon after the

last week of September and the inadequate winter showers combined with frost, hail and cloudy weather in December, January and February reduced the outturn of *rabi* crops.

ASSAM. With the exception of a few local floods of short duration, the province was free from natural calamities during the year. The season was not, however, quite favourable from the agricultural standpoint owing to the uneven distribution of the rainfall. Scanty rains in the flowering season affected transplanted winter rice and the prolonged drought in the sowing season reduced the area under *rabi* crops. The season was generally helpful to autumn rice.

SIND. The *kharif* season was characterised by subnormal rainfall and high temperatures, accompanied by hot winds and dust storms, which affected the cotton crop in Middle Sind. In the non-barrage tracts of Upper and Lower Sind, the rice crop suffered from irregular and inadequate irrigation supply. Other *kharif* crops were in general satisfactory. The scanty rainfall during the *rabi* season, and the humid weather in February, resulted in reduced *rabi* outturns.

HYDERABAD. Except in the Karnatak, the season was not favourable for the *kharif* crops owing to the late arrival of the monsoon and the unusually heavy rains in September and October. The *rabi* season was below normal on account of untimely heavy rains and hail storms in February.

In MYSORE the seasonal conditions were generally good, though the uneven distribution of the rainfall affected adversely the field crops in certain districts.

2. ECONOMIC CONDITIONS

IN common with the rest of the world India showed distinct signs of improvement in her economic condition during the year under report. The prosperity of India depends to a large extent on good harvests and satisfactory prices for her commodities. As already stated, good harvests were obtained for most of the crops during the year. The year also saw for the first time since 1930-31 a distinct, if not spectacular, improvement in the prices of agricultural

commodities. The following table shows the percentage decline in the Calcutta Index numbers for important agricultural commodities during 1935-36 and for the preceding five years, as compared with September 1929.

Percentage decline in the Index numbers on the basis of September 1929

Commodity	December 1930	December 1931	December 1932	December 1933	December 1934	March 1935	December 1935	March 1936
Rice . . .	25	40	50	40	47	43	39	36
Wheat . . .	47	36	34	46	45	47	41	41
Tea . . .	11	47	56	..	16	..	12	..
Oil-seeds . .	43	54	55	56	43	45	37	46
Jute (Raw) . .	50	36	58	58	51	48	38	39
Cotton . . .	53	34	39	53	45	51	44	45
Sugar . . .	22	10	15	24	26	24	19	26

The price-level of rice was distinctly better than in the preceding season and those of wheat and cotton were firmly held if not better. Jute was on a much higher level owing to the smaller crop outturn. The improved world demand for oils and fats was reflected in the higher price level of most oil-seeds ; there was an improvement in the prices of groundnut, castor and rape seed, and linseed prices made a distinct recovery in the last two quarters of the year. Tea in its third year of restriction made on the whole a moderate recovery.

3. The Imperial Council of Agricultural Research

The year under review saw a marked expansion in the activities of the Council.

The State of Kashmir was admitted as a constituent member of the Council and was granted representation on its Governing Body and Advisory Board. Seven Indian States are now members of the Council, *viz.*, Hyderabad, Mysore, Baroda, Travancore, Cochin, Bhopal and Kashmir.

The Council received from the Government of India a grant of Rs. 9·5 lakhs during the year, of which Rs. 2·5 lakhs was set apart for research work connected with the promotion of the sugar industry. In addition to this, the Council was given a special grant of Rs. 21,36,476, which enabled it to finance certain specially approved

schemes of immediate and direct economic importance which had been held up for want of funds. The number of new schemes approved by the Governing Body during the year was thirty-five and the total funds allotted for research up to the end of 1935-36 was Rs. one crore. Of the total number of schemes financed by the Council, sixty-seven are under local departments of agriculture and twelve are carried out by university organizations or private bodies. In the following chapters will be found references to individual schemes of work financed by the Council and in Appendix XIV is given a complete list of schemes of the Imperial Council of Agricultural Reseach to which funds had been allotted up to 1935-36.

An important development during the year was the decision of the Council to invite two specialists from England to report on the work of the Imperial Council of Agricultural Research up-to-date and to make suggestions for future work. The experts selected for the purpose were Sir E. J. Russell, D.Sc., F.R.S., Director, Rothamsted Experiment Station and Dr. N. C. Wright, Director, Hannah Dairy Research Institute, Ayrshire, Scotland.

During the year, the work of the Animal Husbandry Section of the Council was considerably expanded and action was taken on important matters which should lead, in the future, to very material impovement in the organization and development of animal husbandry research in India.

Mention was made in the last review of the appointment of an Agricultural Marketing Adviser to undertake the organisation of agricultural marketing in India. The office of the Agricultural Marketing Adviser was constituted with effect from 1st January 1935 and by March of that year the Central Marketing Officers and the Senior Marketing Officers in the various provinces and Indian States had been appointed. By the end of September 1935, ninety-two full-time marketing officers were operating throughout India and Burma. In addition to this full-time staff, 223 officers were nominated to deal with marketing in the smaller Indian States and Minor Administrations. Towards the close of the year the Coffee Cess Committee arranged to appoint a marketing officer for coffee and

this officer was temporarily attached to the office of the Agricultural Marketing Adviser.

During the year a marketing survey was commenced in respect of rice, wheat, linseed, groundnuts, tobacco, fruits, milk, eggs, live-stock, hides and skins, co-operative marketing and markets and fairs, and a review of the survey work carried out appears in Chapter IV.

A Standing Committee of the Council was constituted for dealing with the problems relating to wheat, and another for those relating to rice, both on the lines recommended by the Crop Planning Conference, 1934.

Amongst the miscellaneous activities of the Council during the year may be mentioned the First Meeting of the Animal Husbandry Research Workers' Conference, which was held from the 17th to 19th February 1936, and was attended by fifty-five workers in all branches of animal husbandry. An agenda of twenty items was discussed dealing with a wide range of subjects.

A meeting of the Soil Science Committee of the Council was held in February 1936, and the Committee reported on a number of new schemes of soil research in addition to examining the progress reports of current schemes.

A meeting of the Locust Committee was held on the 20th and 21st January 1936, at which the progress of locust research and the locust position in India and abroad were reviewed.

The Fourth International Locust Conference was held in April 1936 at Cairo, and India was represented at the Conference by Khan Bahadur Mian Afzal Husain, Entomologist to Government, Punjab.

At the Imperial Botanical Conference, held at Cambridge, in August 1935, and at the International Botanical Congress, held at Amsterdam, in September 1935, India was represented by large and representative delegations. Of the subjects discussed at the Imperial Botanical Conference, the following were of the most interest to India: fruit storage and transport problems, the collection and classification of crop varieties, pasture research, succession of tropical forest types including the application of ecological methods to tropical agriculture and exchange of botanical staff between constituent parts of the Empire.

The discussions at the International Botanical Congress were primarily of a scientific and technical nature and no matters of policy were discussed. The Indian delegation was particularly interested in the discussions on agronomy, cytology and genetics.

The Fifth Triennial Congress of the International Society of Sugarcane Technologists was held at Brisbane (Queensland-Australia) from the 27th August to the 3rd September 1935, and Rao Bahadur T. S. Venkatraman, Imperial Sugarcane Expert, Coimbatore, was the delegate from India. The Congress was organised in two main sections, manufacturing and agricultural. Special discussions were also arranged on laboratory methods for the determination of soil fertility, irrigation and drainage, mechanical cultivation and maturity testing. There were also separate subsections on entomology and cane diseases, virus diseases and quarantine, as well as cane varieties. With this visit was combined a visit to Java where Rao Bahadur Venkatraman visited the Experiment Station at Pasoeroean where very important cane-breeding work is being done, and certain other important centres.

The Fourth Imperial Entomological Conference was held at London from the 19th to 27th September 1935 and two officers on leave, *viz.*, Mr. P. B. Richards, Entomologist to the Government of the United Provinces, and Mr. J. C. M. Gardner of the Forest Research Institute, Dehra Dun, were the official delegates from India.

The Conference discussed the need for the continuance of Empire support to the Imperial Institute of Entomology, the Farnham House Laboratory for the breeding and supply of beneficial parasites and the Laboratory at Slough for investigations on stored products. In accordance with the recommendations of the Conference, a proposal for the temporary continuance of India's contribution to the Farnham House Laboratory and the investigations at Slough on stored products has been sanctioned by the Council.

As in previous years, the High Commissioner for India, London, represented the Imperial Council of Agricultural Research on the Permanent Committee of the International Institute of Agriculture, Rome.

CHAPTER II

ECONOMIC WORK ON CROPS*

THE ascertained area under improved varieties of crops in British India in 1935-36 was approximately 21·4 million acres, as compared with 18·6 million acres in 1934-35. In other words, the recorded area under improved crops has increased by fourteen per cent during the period under review. These figures by no means represent the whole extent to which improved strains have replaced old varieties, as it is almost an impossible task to gauge the full extent

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of the 'natural spread' of improved varieties. Tables I and II show the position so far as it can be ascertained :—

TABLE I

Areas under improved crops in India during 1935-36 (in acres) as far as information is available

Province or State	Rice	Cotton	Wheat	Jute	Sugarcane	Other Crops
			British India			
Madras	1,063,299	617,942	..	..	58,049	205,055
Bombay Presidency proper.	13,524	692,617	25,871	..	13,960	224,830
Bengal	702,126	..	..	1,103,926	277,322	18,047
United Provinces	..	397,000	2,637,000	..	2,167,000	543,700
Punjab	..	2,076,100	3,476,800	..	226,300	..
Burma	1,058,784	5,684	24,290	..	16,197	322,233
Bihar and Orissa	52,849	..	64,329	1,203	429,832	17,132
Central Provinces and Berar.	585,688	505,327	590,025	..	..	365,544
Assam	42,609	..	..	15,890	14,498	5,899
N.-W. F. Province	..	900	15,044	..	148	2,657
Sind	56,765	603,559	88,576	..	..	19,236
Baluchistan	..	..	900	..	..	..
TOTAL FOR BRITISH INDIA.	3,575,644	4,899,129	6,922,835	1,121,019	3,203,306	1,724,338
			Indian States			
Hyderabad	1,765	56,090	1,472	..	17,553	38,468
Mysore	78,819	12,684	2	..	19,273	65,983
Baroda	100	87,215	15,042	..	..	315
Travancore	311	..	..	..	..	..
Cochin	4,002	4,798	..	..	64	97
Bhopal	6	16	21,232	..	1,600	1,740
Kashmir	8,450	..	10,272	..	2,540	25,502
TOTAL FOR INDIAN STATES.	93,453	160,803	48,020	..	41,030	132,105
GRAND TOTAL FOR BRITISH INDIA AND INDIAN STATES.	3,669,097	5,059,932	6,970,855	..	3,244,336	1,856,438

TABLE II

Areas under improved crops in India (so far as information is available)

Crops	British India		Indian States		Grand total for British India and Indian States	
	1934-35	1935-36	1934-35	1935-36	1934-35	1935-36
Cotton	3,731,217	4,899,129	55,501	160,803	3,786,803	5,215,937
Wheat	6,515,427	6,922,835	20,139	48,020	6,535,566	6,970,855
Rice	3,115,769	3,575,644	190,713	91,453	3,306,482	3,667,097
Sugarcane	2,490,930	3,203,306	34,870	41,030	2,525,800	3,244,336
Jute	1,138,298	1,121,019	..	..	1,138,298	1,121,019
Groundnut	611,337	186,045	44,844	65,729	656,181	251,774
Millets*	190,906	338,737	..	341,540	190,906	680,277
Gram*	281,190	331,923	..	502	281,190	332,425
Potatoes*	2,921	8,742	2	525	2,923	9,297
Other crops*	593,760	818,513	511,935	26,138	1,105,695	844,651
TOTAL	18,671,755	21,405,893	858,004	775,740	19,529,849	22,337,668

* Not separately reported by some provinces

1. Rice

On an average, rice occupies about thirty-five per cent of the total cultivated area in India and the table below gives the estimated area and production during the last five years :—

Year	Area in acres (thousands)	Production in tons (thousands)
1931-32	84,374	33,001
1932-33	82,882	31,114
1933-34	83,045	30,813
1934-35	82,507	30,239
1935-36	81,841	27,902

Though the area during the year was only about one per cent less than that of the previous year, the production was nearly eight per cent less, the lowest for the last ten years. The season was a particularly unfavourable one for rice in the important provinces of Bengal, Bihar and Orissa and the Central Provinces.

Rice accounted for ninety-one per cent of the total quantity of food-grains and flour exported during the year. The statement below shows the production and exports of rice from India proper and Burma during the past five years, together with the corresponding figures for 1913-14.

Year	Production in tons (thousands)		Exports in tons (thousands)	
	India Proper	Burma	India Proper	Burma
1913-14 . . .	24,782	4,037	591	1,848
1931-32 . . .	28,799	4,202	236	2,112
1932-33 . . .	26,201	4,913	228	1,638
1933-34 . . .	25,690	5,174	216	1,523
1934-35 . . .	25,835	4,532	206	1,395
1935-36 . . .	22,843	5,018	191	1,213

While the total production of rice in India proper is much higher than in Burma, the exportable surplus is derived almost entirely from the latter country. Of the total tonnage of rice shipped overseas in 1935-36, Burma was responsible for eighty-six per cent and Bengal and Madras for six and five per cent, respectively. Owing to the Indian crop being below average during the last few years, there has been very considerable exports of Burma rice into India, and India continued to be the mainstay of the Burma market. Owing to the imposition of a protective duty of twelve annas per maund on broken rice, the imports of rice, not in husk, into India, which had advanced to 283,000 tons in 1934-35 fell to 90,000 tons during the year.

One of the main activities of the provincial departments of agriculture with regard to this crop being the production and distribution of improved strains to the cultivators, the total area under improved varieties of rice has been increasing and during the year this area was 3,667,097 acres as compared to 3,306,482 acres in 1934-35, the increase being particularly striking in provinces like Bengal and Madras.

Rice research is now being conducted on a much wider scale than ever, chiefly as the result of finances provided by the Imperial Council of Agricultural Research. While some provinces like Madras, Bengal, Bombay and Burma have done considerable work on rice even before the Imperial Council of Agricultural Research came into existence, this body has been responsible both for intensifying this work and for commencement of the work in other provinces like the United Provinces, the Central Provinces, Assam, Bihar and Orissa. Besides the rice schemes under the control of the provincial departments, the Imperial Council of Agricultural Research is also financing such special investigations like the Nutrition Scheme in Dacca University, the Physiology Scheme in the Royal Institute of Science, Bombay, and the Quality Scheme in the Indian Institute of Science, Bangalore.

A Standing Committee on Rice consisting of forty-five members was constituted during the year on the lines recommended by the Crop Planning Conference, 1934.

The output of work during the year was considerable and a brief summary of the same is given below, province by province.

On an average of the last three years, BENGAL contributed to 25·8 per cent in area and 28·8 per cent in production of the total Indian crop. The reported area for the year, 21,092,000 acres, was nearly the same as in the previous year, but the production, 7,208,000 tons, had gone down by nearly twelve per cent.

The plant-breeding work on rice is carried on at Chinsurah, Bankura, Suri and Gosaba stations under the scheme sanctioned by the Imperial Council of Agricultural Research and at Dacca and Barisal. An outline of the nature of work at each of these stations and the tracts of Bengal for which the results from each of these stations are intended, have been dealt with in a previous report. Special attention was paid to the propagation of varieties and strains recommended by the Department. The number of seed-farms increased from 334 to 369, during the year, the area increasing from 3,000 acres to 3,025 acres.

At Dacca farm, which is the headquarters of the Economic Botanist, 2075 types of highland *aus* (autumn paddy), transplanted

aman (winter paddy) and Balam rices were under observation. The most promising of these are usually picked out by preliminary observations for detailed yield tests. During the year thirty-four varieties so selected were under yield trials. Besides the above, a number of hybrid progenies were compared against the parents for hybrid vigour, and there were eight " salt water rices " under yield tests. A large number of F_2 and F_3 generations of crosses were under study, the more important of them being the *aus-aman* cross, which is being studied at the Chinsurah and Bankura stations as well. Histological studies on the distribution of mechanical tissue in the straw, referred to in the previous report, were continued on materials from rices with lodging and erect habits and of their crosses. A study of the somatic and meiotic chromosomes of some few lines and their crosses from the cytogenetic point of view was started. Results reported previously—that copper sulphate treatment preserves the viability of seed during storage—are found to hold good only when the treated seed is stored in air-tight receptacles. In connection with the co-ordinated scheme of marketing survey in rice initiated by the Imperial Council of Agricultural Research, analyses of eighty-nine paddy and eighty-two rice samples, and 209 cooking tests were carried out.

At the Chinsurah station several of the yield tests with *aus* and early *aman* varieties had to be abandoned due to the bad season and persistent drought. Even the regular *aman* tests were a failure as the plantings had to be done very late. A complex cultural experiment in progress with three varieties, five dates of planting, three spacings and three seedling numbers, has shown (*a*) that all the primary effects except the age of seedlings are significant, (*b*) that of the first order of interactions those between variety and age of seedlings, and variety and seedling number are significant, (*c*) that the second order of interactions between (i) variety, seedling number and age of seedling and (ii) variety, seedling number and spacing are significant, and (*d*) that the third order of interaction is significant. The unexpected results obtained at Gosaba that the three months' old seedlings gave a very much bigger crop than

one month seedlings are ascribed to the failure of rains in September and October which hit the young seedlings very badly.

At the Bankura station in addition to the collection and maintenance of types, several cultural and manurial trials were continued. Since the rice area here is steeply terraced, the varietal collections were grouped according to their durations and compared against each other in four different situations. The results of the yield trials during the year were so variable and different from those of the previous year due to the abnormally bad season that much reliance could not be placed on them. For the same reason the results of the complex experiments were also very varying. In a complex experiment dealing with broadcasting, dibbling and transplanting with two ages of seedling, both dibbled and broadcast sowing gave a significantly higher yield than transplanting and between the two sowings, dibbling was better than broadcasting. The pot experiment with regard to the best time of applying Nicifos showed that its application at a much later period than transplanting time is beneficial. Increased doses of Nicifos were, as in the previous year, more effective on yield and tillering than smaller doses.

BIHAR AND ORISSA. On an average for the last three years, the province contributed 16·5 per cent in area and 14·8 per cent in production of the total crop in India. While the rice area in 1935-36 (13,190,000 acres) was not materially different from the average, the production (3,416,000 tons) due to the bad season was nearly twenty-seven per cent less than that of the previous year.

The scientific work is carried on in the central station at Sabour. The sub-stations at Cuttack (Orissa), Gaya (South Bihar) and Kanke (Chota Nagpur) deal with simple selection in local varieties and in addition arrange for the trial of strains evolved at the central station. Nearly 5,000 samples have been collected from different parts of the province and these are being grown and examined with a view to eliminating duplicates and recording morphological characters. This work is now complete for the collections from South Bihar and is in progress for others.

Selection work of types suitable for flooded conditions which is mainly confined to the Cuttack station was also duplicated at

Sabour by subjecting the selections to flood conditions artificially and eliminating the unsuitable types. The selection work in *Gora* rices for Chota Nagpur has resulted in a few improved strains which show promise of being better both in quality and yield than some of the present standard varieties. Of the South Bihar rices, Selection 88 again did better than Kanki II, the standard variety. An early selection I.59 in *dalua* (summer) rices of Orissa, which will save the cultivator at least one irrigation in the hot weather and which is also a heavier yielder than the local rices, has been obtained. Over fifty rice varieties imported from outside the province were under observation for determining their suitability to the Bihar conditions

A study of the root-systems of rice under different conditions of soil has shown the comparatively better developed root-system in *aman* as compared to *aus* rices, and that the root-system is best developed in clayey soils, the mixture of sand in it inhibiting such development. The investigation on the factors governing " Quality of fineness " in rice has shown that the weight of grain per unit length, *i.e.*, $\frac{\text{weight of 100 grains}}{\text{length of the sample}}$ is a much more reliable index than ordinary $\frac{\text{length}}{\text{breadth}}$ ratios.

The several cultural experiments were continued. Trials on spacing and number of seedlings per hole in transplanted rice showed that it is more economical to transplant 9″ apart with only two or three seedlings to the hole. Dibbling of seeds was also found to be superior to broadcasting. The practice of *nigar* (dewatering the field for about a fortnight at a certain stage of the crop) again failed to show any advantage over the normal irrigation practice. In the manurial trials, Ammophos and ammonium sulphate were both equally good as fertilisers and definitely better than sodium nitrate for South Bihar conditions, and superphosphate was not of any value. Manuring of seed-bed did not show any beneficial effect on the subsequent growth and yield of the crop, and it appears that the best time of applying artificial manures to rice is about two weeks after transplanting.

On the physiological side, studies on the mineral and water-requirements of the rice plant have been in progress. Ammonium salts appeared to be much more beneficial than nitrate salts. With regard to the water-requirements of the crop, there appeared to be a good deal of variation within each group of early, medium and late varieties. There is also a well-marked period of high water-requirement which starts about two to three weeks before flowering and continues right up to the flowering time after which it begins to decline gradually. Studies on salt-tolerance indicated the possibility of gradually educating varieties to tolerate salinity. Studies on the dormancy and viability of seed and with different methods of storing have been continued. Desiccating agents like calcium chloride or sulphuric acid were found to help the seed in retaining its viability for long periods, up to twenty-six months. Some of the selections in *dalua* rices were found to have a shorter dormancy period than ordinary varieties.

A study of the F_2 generation of some crosses indicated great complexity in the inheritance of characters, both morphological and agricultural, and the work is being continued.

BURMA claims on an average of the last three years 15·5 per cent of the total area and 17·5 per cent of the total production in India. The area and production during the year were 12,494,000 acres and 5,018,000 tons respectively. Unlike other major provinces, the production during the year was slightly above normal and about ten per cent more than in the previous year. Although Burma is responsible for eighty-six per cent of the total export of rice from India, the quantity exported during the year declined to 2,965,000 tons from 3,599,000 tons in 1934-35. Since the rice industry in the province is dependent on her retaining her foreign market, attempts have been mainly devoted to the production of rices to compete with the high-grade American and Spanish rices in the United Kingdom and Canada.

In addition to the two improved Emata rices, A-28-6 and A-28-8, two bold Ngasein types have emerged successfully from tests conducted at eleven centres. These rices have been approved by the Burma Chamber of Commerce as suitable for both Western and

Eastern markets and seed is now being grown for commercial milling and trial shipment. The seed distribution scheme of rice in Burma, which is well organised with a number of major and minor seed-farms, was responsible for the distribution of 15,468,717 lbs. of seed during the year as against 17,223,597 lbs. during the previous year.

The rice research is carried on at the Central Station, Hmawbi, financed by the Imperial Council of Agricultural Research; while the Akyab, Mayaungmya and Mandalay stations supplement the work at Hmawbi with special reference to local conditions in Arakan, in the Delta and in the unirrigated tracts of Upper Burma, respectively.

The breeding work at Hmawbi consisted of the study of 180 hybrid cultures of crosses between local strains and local strains, and between local strains and exotic varieties to evolve high-yielding types with big, bold and translucent grain suitable for the export market. These cultures were from the F_2 to the F_{11} stage, and in the final stages the strains are not only compared for yield but also subjected to suitable milling tests. A large number of exotic varieties from Siam, Java, America, Formosa, the Philippines and British Guiana were also studied. Most of these did not prove suitable for Burma conditions except two from Siam.

Under genetical studies, the inheritance of sterility proved complicated and no connection was established between sterility and pollen abortion. The inheritance of grain-size was of the usual multiple-factor type, and grain shattering was found to be dominant over non-shattering.

The interesting experiments regarding the investigations into the effects of the soil and climatic conditions and the effects of different dates of harvesting on the quality of rice are not yet complete but should prove of great interest as they are directly concerned with the milling qualities of the grain.

Indications on the best size and shape of plots for experiments with rice have been obtained. Under manurial trials the experiment with a mixture of ammonium sulphate and sodium nitrate has definitely proved that ammoniacal nitrogen is to be preferred for rice.

Investigations on the photoperiodism in rice conducted at Mandalay by the Economic Botanist have shown that the influence of the length of day profoundly affects the time of flowering. By artificially shortening the day a rice variety can be induced to flower in forty days from sowing which would normally require 135 days from sowing. There was, however, much sterility when flowering occurred during the hot day season (April).

MADRAS. On an average of the last three years, this province contributed about 13·5 per cent of the area and to about 18·1 per cent of the production of the total Indian crop. The reported area for the year was 10,478,000 acres as against 11,056,000 for 1934-35 and the production 4,880,000 tons as against 4,981,000 tons in 1934-35.

The research work on rice is being conducted at Coimbatore, the headquarters of the Paddy Specialist, and at four other stations, Aduturai, Maruteru, Pattambi and Berhampore, of which the last is financed by the Imperial Council of Agricultural Research. Nearly forty improved strains have been evolved suited to the varied conditions of rice-growing obtaining in the province and the area under them is rapidly increasing. The progress in the spread of strains was marked during the year. The total amount of seed sold to the cultivators was 2,479 tons as against 1,567 tons in 1934-35. Besides the production of seed directly by the department, large areas of seed-farms on ryots' land under departmental supervision and through agricultural co-operative societies were arranged. The total area in the presidency under the different improved strains of rice including the natural spread was estimated to be 1,063,299 acres as compared to 928,841 acres in the previous year.

While most of the fundamental work on rice is carried at Coimbatore, the sub-stations in the districts deal mainly with simple selection work in local varieties and also conduct agronomic experiments suited to the local conditions. While a little over 2,000 single-plant progenies from half a dozen commercial varieties were under various stages of trial and observation at the different research stations, about twenty, that have finished the trials satisfactorily at the experimental stations, were compared against the

local seed in cultivators' fields in particular tracts for which they are intended. During the year under report, six strains, four from Pattambi, and two from Coimbatore, are being released for general distribution to the cultivators. The two strains to be released from Coimbatore are of hybrid origin combining valuable economic characters. One of these has been bred for resistance to *Piricularia* from a cross between a high-yielding, susceptible variety and a resistant variety. The new strain, in addition to its resistance, gives about ten per cent increase in yield over the susceptible variety in seasons when the disease does not appear, and this increase goes up to thirty to forty per cent in seasons when the disease is prevalent. The other hybrid strain has been bred for its better straw character combined with heavy yield, the parents of the original cross being a high-yielding, weak-strawed strain previously evolved in Coimbatore (Co 3) and a Burma variety with a strong non-lodging straw. At the Aduturai station, a mutant, isolated from one of the strains previously evolved, has been found to breed pure and give nearly a thirty per cent higher yield than the strain from which it was first isolated. This is being tried in the districts. Among the varieties of rice introduced from outside for trial in Madras, one Patnai type is proving superior to the premier Coimbatore strain, GEB 24, in certain districts and a variety, Pichodi, from Hyderabad, is increasing in popularity in parts of the first circle.

Under cultural experiments, work at the Paddy Breeding Station, Coimbatore has shown that dibbling the seed in lines in puddle is just as good as transplanting. At Berhampore, broadcasting was again found to give the same results as transplanting, the optimum seed-rate for the former being forty to sixty lbs. per acre. At Maruteru the advantage of planting seedlings closer in lines and giving a wider space between lines was again demonstrated. At Pattambi no differences were noticeable with regard to seedlings varying in ages from thirty to sixty days if planting is done in the normal season, but for a crop planted out of season the age should not exceed fifty days. At Berhampore the optimum age lies between thirty and forty days, while at Maruteru the advantage

of planting seedlings earlier, twenty to thirty days, is bound up with the thin sowing of the nursery.

Manurial trials with different ratios of nitrogen and phosphoric acid, different forms of phosphatic manures, different quantities of green leaf with and without the addition of chemical fertilizers, conducted at Berhampore and Pattambi, gave the following results. Phosphatic manures, in whatever form, had no response. At Pattambi green manures were better than mineral fertilizers applied to give the same amount of nitrogen. At Berhampore applications of nitrogenous fertilisers over a dressing of green leaves gave definite increases in yield and the increase is progressive with higher doses of leaf application from two to ten thousand lbs. per acre and there is a definite residual effect with the heavier doses.

The subsidised manurial trials at Maruteru for the second crop indicate that thirty-two lbs. each of nitrogen and phosphoric acid either as Ammophos or as a mixture of ammonium sulphate and superphosphate is a beneficial economic dose, that both milled guano and flower phosphate have a similar effect as suppliers of phosphoric acid, that phosphoric acid by itself gives no response and that both inorganic and organic manures have no residual effect. At Samalkota manuring rice land with 6,000 lbs. of green leaf and 1½ cwt. of superphosphate per acre gave the best results. At this station the addition of sand to alter the physical texture, though it had a harmful effect in the beginning, is proving beneficial gradually. The trial with a mixture of sodium nitrate and ammonium sulphate against the constituents singly to supply the same quantity of nitrogen at four stations has not shown the superiority of the mixture over ammonium sulphate.

Studies on the economics of rice-growing gave net profits excluding land-assessment and water rates of Rs. 77 for Coimbatore and Maruteru, and Rs. 88 for Pattambi per acre. Irrigation experiments at Coimbatore and Maruteru showed that in the former place a rice crop (August to January) consumes seventy-eight acre-inches with a duty of about fifty and that in the latter, the crop (June to November) consumes fifty-four inches with a duty of about seventy.

Under fundamental studies carried on in Coimbatore, the inheritance and linkage relationship of some of the morphological characters have been worked out. Progenies of an interspecific cross (*O. sativa* × *O. longistaminata*) showed promise of their economic usefulness. The cytogenetic study of a large number of mutations isolated from the X-rayed material and polyploids was in progress and is expected to be of considerable help in determining linkage groups and the basic number of chromosomes in rice. Among other studies in progress at Coimbatore may be mentioned those relating to hybrid vigour, root development under varying conditions, vernalization, histological studies on the thickness of bran layers in rices and cooking qualities of rice in relation to the method and the period of storage. In hybrid vigour, definite differences were observed between reciprocal crosses, and the quantity of endosperm in the F_1 seeds seemed to contribute to the vigour particularly when the parents differed in grain size. Histological studies showed that the coarse and coloured rices have thicker bran layers than the fine and white rices.

In connection with the marketing survey, a simple laboratory method for cooking test was designed. Two hundred and seventy-five samples of paddy and rice were analysed and cooking values determined for forty samples of rice.

The UNITED PROVINCES contribute 7·8 per cent in area and 6·7 per cent in production of the total crop in India. Both the area and the production, 6,643,000 acres and 1,983,000 tons respectively, were slightly in advance of those of the preceding year. The total quantity of seed distributed during the year was 993,594 lb. of which 76,116 lbs. came from the Research Station, Nagina.

The research work on rice financed by the Imperial Council of Agricultural Research is carried on at Nagina. There were fifty-three varieties comprising indigenous and exotic ones grown as single plant cultures. Of the exotics, those from China, Malay, Texas, etc., appeared promising and will be tried against the standard local variety. Among the indigenous ones, the deep water rices from Bengal tried for similar conditions in the United Provinces proved too late to be of any value.

Over a thousand cultures from hybrids were under study. A fourth of these represented the hybrid progenies of Sathi rice for protection of the ear from rice-bug attack and the various other progenies for evolution of more economic types. In the Sathi cross, useful and promising types have been isolated combining the closed panicle character of the Sathi parent with better quality and increased yield of the open panicle type. Though several of these are earlier than the open panicle type, none of them is quite as early as the Sathi type. Now that apparent homozygous selections have been obtained, their performance in yield will have to be compared against the local types. About fourteen promising cultures were obtained from the other crosses.

The several manurial and cultural trials were repeated during the year. The one important observation made in the several manurial trials was that there was no difference among the treatments and none of them did better than the control. This extraordinary result suggests (and this requires confirmation) that if rice is planted after a *rabi* gram crop, as was the case during the year, and if the soil is otherwise in a satisfactory state of fertility, the addition of manures is uneconomic. Different seed-rates in the nursery, five to fifteen seers per acre, showed that cowdung in the nursery had no significant effect upon the subsequent yield of the transplanted crop; similarly seedlings of varying ages, twenty to fifty days, showed no difference in their performances. An experiment with T 21, a medium-early rice, showed a great and highly significant increase in yield in favour of sowing before the break of monsoon early in June, over sowing at the break of monsoon in July, and over transplantation at the break of monsoon from nursery sown at the end of May.

Interploughing of the broadcast crop one month after sowing failed to give any effect. Different seed-rates from twenty to thirty-five seers per acre for a broadcast crop in an early variety failed to show any differences. An experiment with different quantities of water, forty, sixty and eighty acre-inches, showed no differences among them, indicating that forty inches was quite enough.

Studies on germination and viability of rice seed showed that in early and medium ripening types the panicles might be harvested twenty days' after their emergence without affecting the viability of the seed adversely. This agrees with the observations made in Madras and Burma, but the quality of the rice obtained has been noted to be poor. In late types, germination was very poor in twenty days' old seeds, the maximum germination being obtained only in forty days' seed. An examination of longevity of the seed showed that rice retains its germinating power fully for about ten months after harvest and then declines, but a small percentage of the seed remains viable even after twenty months.

Hulling trials showed a correlation between fineness of grain and breaking percentage although this correlation with grain shape is not very strict. The fine-grained types gave a higher percentage of broken grains than bold fine, medium fine and short and round types. With regard to breakage during milling, *sela* (crude parboiling of paddy) was superior to "dry" hulling. Though storage improved the hulling properties, the hulling quality did not differ between transplanted and broadcast rice.

Among other items of interest under study at the Nagina station may be mentioned the cytogenetics of haploids, hybrid vigour and environmental effect—spacing and manuring—on the development of the awn.

The CENTRAL PROVINCES AND BERAR contribute 6·9 per cent in area and 5·8 per cent of India's total on an average of three years. Both the area and production, 5,665,000 acres and 1,484,000 tons respectively, were normal during the year. The total quantity of rice distributed as seed during the year was 1,29,66,250 lbs.

The research work on rice for the province, financed by the Imperial Council of Agricultural Research, is carried on at Raipur and as a result of one of the stipulations on the grant, special emphasis is being laid on bio-chemical problems.

Results of chemical analysis have shown that a high percentage of total phosphoric acid in the soil does not necessarily lead to a high yield in rice, and that there appears to be an inverse relationship between the lime-content of the soils of a particular tract and the

yields of rice obtained. Determinations of soil-acidity have shown that in the case of most of the soils examined, the acidity increases with depth and, as reported in the past, high yields of fine varieties of rice can be obtained only from neutral or slightly acidic soils.

Most of the soils examined showed a lack of humus, its percentage being highest within the top six inches. The humus content did not show any relationship to the carbon-nitrogen ratio, which varied widely with different soil groups and was lower at a depth of six to twelve inches than in the top six inches of the soil.

In pot-culture experiments synthetic manures prepared from *karanja* (*pongamia*) leaves and rice straw were not quite as effective as farmyard manure though they did bring about marked increases in yield. Disintegrating raw bones with alkali gave a product with 17·5 per cent phosphoric acid and 0·9 per cent nitrogen and costs only Rs. 2-7 per 100 lbs. and this was found to compare very favourably with superphosphate for rice.

The plant-breeding work at Raipur, which represents the Chhattisgarh tract, is supplemented by trials at Waraseoni and Jubbulpore representing the Wainganga Valley and northern province, respectively. The existing varieties of rice grouped according to their times of ripening and quality were tested for yield at Raipur, Waraseoni and Jubbulpore, and 168 out of 803 so tried have been retained for further trial. The hybridisation work in progress has got a double object in view, namely, securing heavy-yielding types and types with deeply pigmented morphological parts as leaf-sheath, auricle, etc., to distinguish them easily from wild rice (*karga*). Three types already evolved meet the second requirement and are being recommended for growing in fields infested with wild rice.

The different field experiments were continued. Experiments with nitrogenous and phosphatic manures either singly or in combination showed that there was no response for nitrogen even up to forty lbs. per acre and the response to phosphoric acid did not vary for applications of twenty to forty lbs. per acre. Comparison of Nicifos with ammonium sulphate showed that the former had a residual effect while the latter had not. Varying doses of Nicifos from fifty to three hundred lbs. per acre all gave significantly higher

yields than the no-manure plot and the higher doses left a greater residual effect than the smaller doses. The effect of manuring the nursery with Nicifos was not perceptible.

The cultural experiment with *biasi* (broadcasted and subsequently cross-ploughed), broadcasting, drilling, etc., showed that in *matasi* (sandy loam) land, in all varieties tried, early and late, transplanting was better than *biasi*, broadcast-sowing and drilling and it was only in a medium ripening variety that *biasi* was found to be better than broadcast-sowing. In *dorsa* (clayey) land transplanting and *biasi* gave higher yields than broadcast-sowing and drilling in medium and late varieties. In the case of the early variety, *biasi* was definitely better than broadcasting and drilling, but the difference between broadcasting and transplanting was not significant.

ASSAM comes next to the Central Provinces in her contribution to the total rice area and rice production in India which are 6·1 and 5·4 per cent respectively on a three years' average. Unlike the neighbouring province of Bengal, both the area (5,292,000 acres) and production (1,610,000 tons) during the year were higher by ten and 7·5 per cent, respectively, over the figures for the year 1934-35.

The research work on rice is carried on at the two research stations, Karimganj and Titabar, run from provincial funds. The new station at Habiganj to study the deep water rices of Assam, of which there is a large area in the province, started working with the funds provided by the Imperial Council of Agricultural Research.

A certain number of strains, selections and cross progenies suited to the conditions in the province have already been evolved and distributed to the cultivators, such work forming one of the important activities of the department. During the year 1,17,633 lbs. of seed was distributed to the cultivators.

The work at Karimganj and Titabar was continued with varietal, cultural and manurial trials besides breeding and selection in *aus*, *sail* (transplanted winter rice) and *asra* (shallow water winter) rices. One thousand twenty-eight pure lines and 3,002 cultures from cross progenies were under observation at Karimganj and 915 pure lines and 1,190 cross progenies at Titabar.

Among established types, 106 were under preliminary trials and twenty-five under final trials in the two centres. One of the hybrid strains in *sail* rices, S C 638-3, with an acre yield of 3,824 lbs., proved decidedly superior to all the existing types and this is proposed to be sown on a field scale. Of the *asra* rices, a new hybrid, Ar C 353-140, and a pure line Ar 109-1, Dhalbadal, were found definitely suitable for distribution, the former being selected for earliness and good yield and the latter for its strong erect habit and high yield.

Under manurial trials three doses of cowdung, one hundred, two hundred and three hundred maunds per acre, with two *aus* varieties, were experimented with at Karimganj and three doses, 0, 100, and 200 maunds per acre with two *ahu* (autumn) varieties at Titabar. At both the places the manures had a distinct effect on yield, there being no differences among individual doses and no differential response between the varieties. An elaborate complex cultural experiment with four factors—three varieties, four times of planting, three spacings and three numbers of seedlings per hole—was conducted at the two stations. The results showed that while all primary effects were significant at Titabar, only varieties and number of seedlings were significant at Karimganj. Seeds of three departmental strains grown at three centres for over three years were collected and compared against the farm seed to see if there was any deterioration. The experiment showed no differences.

Under the scheme of analysing market samples of paddies and rices to fix grade standards, 122 samples were examined at Karimganj and twelve samples at Titabar. Cooking tests were also conducted with twenty-two samples of rice.

At the Habiganj station, which has been brought to a working condition during the year, 234 *aman* or deep water rices collected in 1934-35 along with 147 new samples were under observation with a view to classifying them mainly on the characters of the spikelet, grain and straw. The problems relating to the deep water rices are peculiar and entail special equipments to study them properly. Though only one year's work has been done which is mostly of a preliminary nature, valuable information has been collected on

several of the problems like rate of growth, nodal rooting and tillering in relation to rise of water-level, effects of continuous and intermittent submersion of seedlings, etc. Experiments have shown that the period of dormancy is quite short for the *aman* seeds.

In the *boro* (spring) rices on which also work is in progress at this station, 450 of last year's selections and sixty new samples were under observation. While almost all *boro* rices are coarse, evolving fine-grained *boros* is receiving attention firstly by the introduction of such rices from outside.

Cultural experiments with time of sowing and seed-rate in *aman* rices and complex experiments involving time of planting, spacing, age and number of seedlings per hole in *boro* rices have been laid and preliminary results obtained.

BOMBAY contributes on an average of the last three years 2·4 per cent in area (1,832,000 acres in 1935-36) and 3·1 per cent in production (740,000 tons in 1935-36) to the total rice crop in India. Bombay imports considerable quantities of rice from Burma and other provinces and re-exports portion of it to Africa, Persian Gulf, etc. During the year over 30,000 lbs. of seed was distributed to the registered seed-growers. The area under the improved strains is estimated to be 13,524 acres.

The main breeding work is carried on at Karjat station and this is supplemented by work at Mugad and Kumta farms. A large number of hybrid cultures, involving the well-known K 42 strain as one of the parents, twenty-eight selections from Zinya, fifteen from Bhadas and forty-six from Kada and Jirbuti, were under observation. Strains K 184 and K 540 were tried at a number of centres in Gujarat, North-Central and South-Central divisions against the locals. While K 540 is not a definite heavy yielder, the rice being fine, fetches fifteen to twenty rupees more per candy than local rices in the market.

In the North-Central division, ammonium sulphate is not being recommended now as a fertiliser because of its depleting effect on the lime and organic contents of the soils. Trials have been carried out with castor and safflower cakes to supply forty and sixty lbs. of nitrogen per acre and it is found that castor cake is definitely

more profitable to use. The trial with the mixture of ammonium sulphate and sodium nitrate at Karjat did not show its superiority over ammonium sulphate. In the South-Central division arrangements have been made to multiply departmental strains rapidly through Taluka Development Associations.

With a little over a million acres under rice (1,043,000 in 1935-36) SIND contributes about 1·5 per cent of India's production (370,000 tons in 1935-36). During the year 497,822 lbs. of seed was made available to the cultivators. Breeding work is carried on at Larkana, which has already resulted in the three improved strains, Kangni 27, Jajai 77 and Prong 36, and these are being grown on a large scale by cultivators in North Sind. With the opening of the Barrage Canal system the problem of evolving types which could be planted in May-June instead of July is being kept in view. Trials with the improved types for such early planting have shown that such early plantings are not only possible but profitable. The improved hybrid strain obtained by crossing Kangni 27 with Kolamba 184 and which has been named 'Silver Jubilee' rice was tried at several places on a large scale and has given satisfactory results, the yield per acre going up to 3,400 lbs. Several other late and early maturing selections from hybrid material and high-quality rices obtained from outside were under trial at the Larkana station. The trial of varieties for resistance to *kalar* was continued as in previous years and gave very similar results.

Breeding work for Lower Sind was continued at Matli with the selections from the local varieties, Motza and Ratrya. Five of the best in each were tried on a large scale during the year with satisfactory results. A large number of exotic varieties have been tried but most of them except Bengals and Basmati are not promising.

Experiments with duty of water showed that a normal crop with fairly good yields can be raised in a normal season with thirty duty, the crop consuming about forty-five to fifty-five acre-inches. A higher duty than thirty was found to delay transplanting with the risk of damage to the transplanted crop by rains.

Rice is a minor crop in the PUNJAB and occupies less than a million acres. The breeding work for the province is carried at the

Kala Shah Kaku station and a total supply of 355,962 lbs. of seed of improved varieties was distributed during the year.

A large number of local varieties (sixty-four) have been tested at the station and variety 246 Suffaida, continues to be outstanding. Under cultural trials transplanting is found to be better than broadcasting (about thirty-one per cent more) and seedlings of ages above six weeks were better than younger seedlings below five weeks.

In connection with the fixing of grade standards, 312 provincial samples were analysed. Since the Kala Shah Kaku station does not meet the requirements of the Kangra valley and other hill-growing rice tracts, a Rice-breeding Sub-station has been started at Saldah near Palampur.

The HYDERABAD STATE contains over a million acres under rice (1,064,000 acres) in 1935-36, but produces only about 336,000 tons of rice. Selection work has given two early types, Himayatsagar 206 and 504, the former coarse and the latter fine. Other more promising types are under test. The area under improved strains during the year is 1,765 acres.

Manurial experiments have shown that nitrogen is the chief requirement of the Hyderabad rice soils and Nicifos gives satisfactory results. The best nitrogen : phosphoric acid ratio is found to be 1 : 1. A large number of *rabi* crops are being tried in place of the *tabi* rice, where two rices are grown in the same year of which the second suffers from water scarcity.

The area under rice in MYSORE during the year was 741,000 acres and the estimated production 222,000 lbs.

The breeding work is carried on at the Naganahalli station. The attempt is to get some selections which would be an improvement over GEB 24, a Madras strain, which still continues to be the most extensively cultivated variety in the State. Some of the new Mysore selections are very promising and district trials have created a demand for them by the cultivators. During the year 65,000 lbs. of paddy seed was made available to the cultivators and the area under improved strains in the State is estimated to be 53,000 acres.

The area under rice in the TRAVANCORE State is small and nearly fifty per cent of the requirements has to be met by imports. There

is an attempt to increase local production by making available for rice cultivation lands suited to it and improving the facilities for irrigation. Side by side attempts are in progress by the Agricultural Department to improve the yields in existing areas by the spread of improved strains and by advocating better manuring practices.

Two selections, TEB 1 and 2, are found to be heavy yielders besides being resistant to alkalinity and these are being distributed to cultivators. During the year 6,889 lbs. of seed was sold to the ryots. Certain manurial trials in progress have shown that addition of bone-meal, fish guano or laurel cake definitely increases the acre-yields.

COCHIN. Rice is an important crop of the State and though no regular breeding work is done here, simple selection has been attempted and one of the strains evolved in variety Chitteni is becoming popular in some tracts. Arrangements have been made to multiply this rapidly. Manurial trials in rice have shown the importance of organic manures. A large number of strains from the Madras experimental stations has been introduced for trial in the State.

Breeding work on a small scale is being carried out by the Imperial Department of Agriculture at KARNAL station. In the yield trials conducted during the year, two fine rice selections, T 125 and T 130, proved better than others.

A preliminary experiment with four types of rice showed that transplanting seedlings with regular spacings was better than the local practice in which no regular space is maintained.

Rice physiology.—Prof. Dastur made a detailed study of the physiological processes of the rice plant for quite a long time at the Royal Institute of Science, Bombay. The study was first confined to the determination of the osmotic and suction pressures of the roots and leaves, the photo-synthetic activities of the leaves, the intake of nitrogen and the relative growth-rate of plants. The changes in the osmotic pressure produced by the absorption of a salt were later made use of for determining whether a salt was absorbed by a plant or not, the salts examined being ammonium

sulphate and sodium or potassium nitrate. The rate of photosynthesis of the leaves of the rice plant was also determined at different stages of growth. It was found that the plant absorbed ammonical ions in the earlier stages and nitrate ions in the later stages. The values of the soils treated with nitrate, ammonium sulphate and a mixture of the two were found related to the isoelectric point of the plant tissues determined by the measurement of the rates of diffusion of the chlorine ions from the living tissues kept at different hydrogen-ion concentrations. The results of the above investigations led to the practical suggestion that a mixture of ammonical and nitrate nitrogen would be a better source of nitrogen to the rice plant than either used singly, and that it would be beneficial to manure the plants just before it passes through the stage when its relative growth is at its maximum. The suggestions were first put to practical test in pots and later in specially prepared beds and got confirmed.

The above investigations were later extended with a grant from the Imperial Council of Agricultural Research for a period of three years. The study of the ammonical, nitrate, organic and total nitrogen contents of the rice plants manured differently, and the extension of the experiment to field-scale trials were then undertaken. It was found that the average of the percentage increase of total nitrogen at different stages of growth of the shoots was thirty-one in the case of the mixture treatment (ammonium sulphate *plus* sodium nitrate), seventeen in the case of ammonium sulphate and seven in the case of sodium nitrate over the control. In the case of the roots no such differences were noticed. In the following year field trials were carried out at three places, Botanical Gardens of the Royal Institute of Science, Goregaon (Thana district) and Talaugur (Surat district). The results showed that the mixture treatment was better than ammonium sulphate in the light soils of Konkan area, while in the heavy soil of Gujarat ammonium-sulphate was better than the mixture. The experiment was repeated again in 1934 at Goregaon in private lands with suitable replications, and the total yields of the treatments definitely showed a big advantage in favour of the mixture

treatment. The Imperial Council of Agricultural Research in reviewing the progress report of Prof. Dastur's work in 1934 suggested that the different agricultural departments in the provinces might carry out suitable experiments in their rice stations to test such a practical result obtained by Prof. Dastur, *i.e.*, the superiority of a mixture of ammonium sulphate and sodium nitrate to either constituent as a fertiliser for rice. Several departments had carried out the trials, and it is found from the reports available that with the exception of Travancore, in no place has the mixture proved better than ammonium sulphate.

Dacca university scheme.—This scheme financed by the Imperial Council of Agricultural Research at the Dacca University is concerned with the mechanical analysis and study of the physico-chemical properties of laterite soils besides the study of the nutrition of the rice plant and it is only the last aspect that is dealt with here.

Previous observations that the Dacca and Faridpur soils are able to fix nitrogen under water-logged conditions were extended by experimenting with a large number of soils obtained from different parts of India. All of these soils were found to fix nitrogen, the amounts fixed being greater in slightly alkaline soils than in soils with lower *p*H. The nitrogen-fixing capacity of the latter soils was, however, greatly increased by the addition of lime. Attempts to get the nitrogen-fixing green organisms in a pure state did not succeed. The question of culturing in a pure form the different algae found in rice soils being extremely difficult and requiring special training, one of the research assistants at Dacca has been sent abroad for training under Prof. Fritsch in London. Fixation of nitrogen in rice soils under dry cultivated conditions was next studied by incubating soils under optimum conditions of temperature and moisture. Though the nitrogen of the soil increased in the beginning, the increase was soon followed by a loss. Experiments with *boro* rice confirmed the previous findings about the occurrence of nitrogen-fixing organisms in the leaves of rice plant, but the role of these organisms could not be ascertained for want of a suitable technique.

In water cultures there was a considerable loss of nitrogen from culture solutions during the seedling, flowering and ripening stages of the plant, the loss during the vegetative growth being, however, negligible. Another observation that has been recorded is that there is considerable absorption of nitrogen by the plant during the final stages of growth.

Field experiments under this scheme refer to the attempt at amelioration of the Dacca laterite soil by treating it with lime, Nicifos, and sulphates of potash and magnesium, given singly and in all possible combinations. This year's results show that Nicifos and lime increase the grain yield, and there is an interaction between the two. While Nicifos by itself gave a big increase in yield, this increase went down with increased doses of lime, thus showing the injurious interaction of lime on Nicifos.

Investigations on the quality in rice.—This scheme financed by the Imperial Council of Agricultural Research is carried on at the Indian Institute of Science, Bangalore. The investigations were first devoted to the study of (1) the changes in the composition of raw and parboiled rice on polishing, (2) the distribution of nitrogen and phosphorus in raw and parboiled rice grains and (3) the influence of parboiling on the milling quality of rice.

The most outstanding results obtained so far are : (1) with the same degree of milling, polished and parboiled rice is usually richer in nitrogen and phosphorus than raw rice, (2) during parboiling, part of the nitrogen and phosphorus present in the germ and bran is transferred to the endosperm which is thus enriched and (3) that parboiling by itself does not confer any special quality which makes the product nutritively superior to raw rice and (4) the richness in both nitrogen and phosphorus of ordinary commercial samples of parboiled rice is due partly to the practice in South India of using coarse and coloured rices, which have thicker bran layers for parboiling and partly to the parboiled rice not being polished to the same extent as raw rice. The investigations have now been extended to the study of (1) the digestibilities of different rices *in vitro* and their nutritive values by feeding trials with pigeons, (2) the amylase system of rice grain during ripening and

germination and (3) cooking qualities of stored as well as unstored rice.

Complementary to the scheme at Bangalore, histological studies on the rice grain are carried on at Coimbatore. In this study the time of formation and development of the starches and proteins in the different parts of the grain of a few typical varieties are being followed. Suitable microchemical tests have been evolved to trace the formation of the proteins. The protein layers are found to be definitely thicker in coarse and coloured rices and besides the aleorone layers, proteins are found in the outermost cell layers of the endosperm. The changes in the quality of rices as measured by their cooking values with different methods of storing and period of storing are also being investigated.

2. Wheat

WHEAT occupied on an average about ten per cent of the total cultivated area in India. Of this the reported area under improved wheats exceeded $6\frac{3}{4}$ million acres, no small fraction of the total wheat area. The estimated area and yield of wheat (including Indian States) during the last three years are given below :—

Year	Area in acres	Yield in tons
1933-34	36,077,000	9,370,000
1934-35	34,490,000	9,729,000
1935-36	33,631,000	9,434,000

The total outturn for 1934-35 and 1935-36, respectively, was higher than for 1933-34 in spite of the smaller acreage.

The export and import figures during the last three years were as follows :—

Year	Exports in tons	Imports in tons
1933-34	2,000	18,300
1934-35	11,000	7,400
1935-36	9,600	13,100

The bulk of the imports was limited to the purchases of the Indian flour-mills for milling for re-export under the drawback scheme. During the year under review the import duty was Re. 1-8-0 per cwt., but in view of the improved level of world prices, it was reduced to Re. one per cwt. with effect from the 9th April, 1936.

THE IMPERIAL AGRICULTURAL RESEARCH INSTITUTE. Deficiency of winter rains and incidence of rust had an adverse effect both on yield and bushel weight of wheats at Pusa. Pusa 52 gave the best outturn in the multiplication plots. Pusa 80-5 gave the best bushel weight. The demand for improved Pusa wheats continued to exceed the supply. For Pusa 4 alone indents amounting to 103,731 lbs. were received. This wheat is increasing in popularity in the Bombay-Deccan. Pusa 52, which is so well suited to Bihar conditions, remained the dominant wheat in that province. There was a growing demand for Pusa 80-5 in the Jullundur Circle of the Punjab.

The new hybrids, Pusa 120 and Pusa 165, were tested for their yields for the third year in succession at a number of farms in the United Provinces and the Punjab. The results taken collectively indicate that Pusa 165 is one of the highest yielding wheats evolved at Pusa.

Pusa 120, which suffers from a tendency to shed its grain when ripe, has been found under greenhouse tests conducted by Dr. K. C. Mehta of Agra to be very highly resistant to the three physiologic races of yellow rust so far recorded in India. It should prove of much value as a parent for breeding for rust-resistance.

At the Botanical Sub-station, KARNAL, the new Federation hybrids, Pusa 121, 122, 125 and 126, which are early, bearded and non-shattering, were compared with Pusa 80-5 and Pusa 165. The varieties stood in the following order in respect of yield :—Pusa 126, Pusa 125, Pusa 121, Pusa 165, Pusa 80-5 and Pusa 122. The differences between the first five strains, however, were not significant. In another yield trial the late-maturing hybrids, Pusa 123 and 124 were tested against Pusa 114, Pusa 120, Punjab 8-A and Punjab C 518. Pusa 123 out-yielded all the others save Punjab

C 518. Selection work with the object of securing a non-shedding strain like Pusa 120 was in progress. The Karnal Sub-station distributed large quantities of seed of improved wheats and the demand was in excess of the supply. About 48,000 lbs. of seed of improved varieties was distributed for sowing.

The work of breeding for rust-resistance was continued at SIMLA by the Botanical Section of the Imperial Agricultural Research Institute in collaboration with Dr. Mehta of Agra University. The F_1 populations of the various crosses were grown during the year under report and certain of these were tested in the seedling stage for resistance against physiologic races of the three rusts. Resistance was found to be dominant in certain crosses and recessive in the others. The crosses made with the object of securing resistance to brown and yellow rust involved hybridization among *vulgare* varieties, and vigorous and fertile F_1 plants were obtained. With black rust, where interspecific crosses between *T. dicoceum* (Khapli) and *vulgare* wheats were necessary, considerable difficulty was met with and only shrivelled grains were obtained most of which either did not germinate or produced plants which died in the seedling stage. Out of those which survived only one plant gave three seeds, the rest proving sterile. In view of this sterility, it may be necessary to transfer the resistance of Khapli first to *durum* wheat with which it readily crosses and then to transfer it from *durum* to *vulgare*. Alternatively it may be possible to make use of the adult or field resistance of certain *vulgare* varieties to black rust.

A large number of exotic and Indian hill varieties were under study with the object of discovering strains suitable for breeding.

With the co-operation of the Nepal Government, an intensive search for early appearances of rust on wheat and barley was made from Tanakpur to Nautanwa *viâ* Silgarhi, Dailekh, Sallyana, Piuthan and Tansing.

The problem of rust dissemination was further studied. The pathogenecity of all three physiologic races of yellow rust was tested on seventy hosts and the seedling resistance, in the

green-house, of forty-eight hosts to four physiologic races of black rust. Forty-one hosts were also tested with two races of brown rust.

The PUNJAB is the most important wheat-producing province. On the average of the last three years, the Punjab had about twenty-seven per cent of the total area under wheat in India and the produce was thirty-one per cent of the total outturn. The area under wheat in 1933-34 was 9,773,000 acres but decreased to 9,038,000 and 9,300,000 acres in 1934-35 and 1935-36 respectively. The yields for these two years were 3,042,000 tons for 1934-35 and 3,053,000 tons for 1935-36 and show an increase over the yield, 2,794,000 tons, for the preceding year. Excepting February which was cold and moist throughout, the season as a whole was rather hot and dry. Yellow rust appeared in this month but did not do any appreciable damage. Black rust appeared in April on late-sown crops but the damage was not severe. Harvesting and threshing took place under almost ideal conditions and the yield was about normal.

While 8-A was most extensively grown in the province, the area under Cross 518 was increasing. The latter had out-yielded 8-A in almost all places in comparative trials on the departmental farms. Cross 591, owing to its grain quality and high yield, is also so rapidly becoming popular that the demand for it was in excess of the supply. The strain is now quoted in the Okara market under its own number and fetches a premium of four annas, or more, per maund. It gave good results in trials conducted by the Institute of Plant Industry, Indore. On the departmental farms on different types of land it showed better results than 8-A; it out-yielded 9-D under late-sown irrigated conditions for the third time and for such conditions it would now replace 9-D. The variety 9-D, however, would continue to be suitable for *barani* (rain-fed) sowings and for the Kangra Valley where it has given good results. C-409 has yielded better than 8-A and has proved a suitable *barani* wheat for the North Punjab. A few other cross-bred wheats gave encouraging results and are being further tested. About 3,275 maunds of pure, smut-free seed of four improved varieties was

supplied to Deputy Directors of Agriculture and large growers for further multiplication and distribution.

Fifteen new crosses were made during the year. An intergenic cross between rye and wheat was made in Lahaul, but the F_1 proved to be absolutely sterile. The attempt to grow a summer crop of wheat and barley hybrid material at Lahaul, in succession to the *rabi* crop at Lyallpur, was repeated with success.

The UNITED PROVINCES is the second largest wheat-producing province having, on the average of the last three years, twenty-two per cent of the total wheat acreage in India and producing twenty-six per cent of the total crop. The wheat acreage of 8,453,000 in 1933-34 decreased to 7,549,000 in 1934-35 and to 7,053,000 in 1935-36. The total production in these years was 2,537,000, 2,523,000 and 2,498,000 tons respectively. The variety C 13, developed by the department, maintained its high-yielding capacity. This fact coupled with its milling quality is responsible for its increasing popularity. Pusa 4 and 12 continued to be the main wheats of the province, but Pusa 52 was spreading in the Eastern Circle and Punjab 8-A in the western districts. The new varieties, Punjab C 518 and Pusa 111, 112 and 165, gave promise of replacing some of the older varieties.

The CENTRAL PROVINCES is the third most important wheat-growing province of India. On the average of the last three years, the area under wheat in this province was ten per cent of the area under wheat in India. The acreage under wheat in these years was 3,441,000 in 1933-34, 3,626,000 in 1934-35 and 3,389,000 in 1935-36 and the yields for these years were respectively 715,000, 763,000 and 641,000 tons, which come to about seven per cent of the total crop.

Three of the strains Nos. 76, 281 and 267 from hybrids between A-115 and Australian and Palestine wheats were reported to possess a higher degree of resistance to rust than A-115 on Government farms in the Northern Circle. Seed of these was now available to extend their cultivation on cultivators' fields. Selection work on Haura variety with the object of evolving an early, awned, hard

wheat suitable for the Southern Circle again indicated the superiority of No. 116 over the two strains, Nos. 11 and 82.

For the Plateau districts, work on another set of crosses to breed early, awned, rust-resistant, good-yielding types was continued. Of the twelve strains from the crosses, AO13 × Pusa 4 and AO90 × Pusa 4, Nos. 3439, 3463 and 34101 gave promising results.

Work to improve the Haura variety in other economic characters besides yield was in progress. It has been crossed with Khapli and No. 58 (Media × Bansi).

Work on breeding for rust-resistance was also in progress. Inheritance of certain characters and their correlation with yield were also under study.

In the BOMBAY PRESIDENCY wheat occupied 1,926,000 acres in 1933-34, 1,734,000 acres in 1934-35 and 1,714,000 acres in 1935-36. The outturns for these years were 328,000, 308,000 and 318,000 tons respectively. Yield trials with the two new strains Bansipalli 900 and BG 8-1 were continued. The latter proved to be a decidedly better yielder than Bansipalli 808, but its grain is not so long and lustrous. Bansipalli 900, on the other hand, has long lustrous grains but is low yielding. It is, however, very early and for that reason may be suitable for shallow soils. A large number of strains derived from crosses between Bansipalli and Baxi and other wheats were also under trial. Some of these were very promising. The ninety-seven selections obtained from bulk samples of Khapli in the previous year were grown and found to differ in germination capacity, flowering and size of spikelets. The best Bombay wheats were crossed with *T. viticulosum* and *T. typicum*.

Manurial experiments on the Jalgaon Farm indicated that sulphate of ammonia applied at the rate of twenty lbs. per acre at sowing time was significantly effective in increasing the yield. An experiment to determine whether rolling of wheat two and three weeks after sowing has any beneficial effect on tillering and subsequently on the outturn showed that the treatment does not lead to an increase in yield.

The introduction of the Gujarat wheat-thresher has practically solved the problem of threshing wheat economically. It has superseded several indigenous and other methods of threshing.

Large quantities of improved seeds were distributed to owners of private seed-farms and to registered seed-growers. The principal strains under distribution were Bansi 224, wheat Nos. 168 and 808, and Pusa 4.

During the ten-year period immediately prior to the opening of the Lloyd Barrage and Canal Systems in SIND, *i.e.*, 1922-1932, the average annual acreage under wheat in the province was about 486,000 acres. With the establishment of assured and perennial irrigation, resulting from the opening of the Barrage Canal Systems, the acreage has considerably increased, the increase being confined almost entirely to the irrigated crop. On the average of the past three years, the acreage under wheat in Sind was 1,157,000 which comes to about one per cent of the total acreage under wheat in India. The produce amounted to 278,000 tons which also approximates to one per cent of the total. The area under irrigated wheats has, because of various causes, fallen since 1933-34 from 1,048,800 acres to 870,600 acres in 1935-36.

The Agricultural Department has evolved, by selection, improved wheats suitable for the main wheat-growing tracts of the province. Out of these C Ph 47 (improved Phandani) is suitable for irrigated tracts and North Sind. The variety A T 38 (improved Thoree) is suitable both for irrigated and *bosi* (without cold season irrigation) conditions in North Sind and Right Bank areas. The wheat H S W III (improved awned Bujri) is suitable for Lower Sind. The Department has acclimatized certain varieties from other wheat-growing tracts of India and their cultivation is extending. Notable amongst these are Punjab 8-A and Pusa 114. Pusa 114 is already being extended in the districts and is rapidly increasing in popularity owing to its resistance to rust.

The activities of the department have been directed towards producing high-yielding, early-maturing, rust-resistant, strong wheats.

The strain 258 G S W, a selection from local wheat, gave promising results, being considerably higher in yield than C Ph 47.

The strains No. 139 (A T 38 × Pusa 12) and No. 37 (C Ph 47 × Pusa 12) were also found to be distinctly high yielders. A number of cultures from C Ph 47 × Pusa 114 were grown in the F_4 generation and some of these were found to be fixed.

Experiments on wheat cultivation and agronomy were conducted at the Agricultural Research Station, Sakrand, and at the Mirpurkhas Seed Farm. At the former place the work was mainly confined to trials of different methods of sowing, *i.e.*, drilling, broadcasting and to irrigation practice. With regard to irrigation practice, research work has shown that early irrigation water, *i.e.*, in October and November, can be profitably utilized for soaking lands in which the moisture can be conserved by suitable tillage methods till wheat is sown late in November or early in December. The work at the latter place was directed towards a study of spacing, depth of sowing and *bosi* wheat cultivation.

Three years' experimental work indicates that a spacing of fifteen inches between rows gives a significantly higher yield of wheat, the increase amounting to about fifteen per cent, than closer spacing, *viz.*, nine inches. The previous years' results as to the advantages of deeper sowing, *i.e.*, three inches in comparison with shallow sowing, *i.e.*, one and one-half to two inches, were confirmed. The average increase in yield during the past three seasons due to the deep sowing amounted to fifteen per cent.

Under the seed extension scheme, 408 maunds of seed were distributed on Government Farms in Sind on an area of 650 acres and 3,966 maunds of seed produced on Government Farms were distributed among 'A' class growers for multiplication. 13,709 maunds of seed (produce of the previous year's registered seed-growers) were distributed by the Sind Central Co-operative Bank among 'B' and 'C' class growers with the assistance of the Agricultural Department.

The area under wheat in BIHAR was 1,143,000 acres in the year under review as against 1,197,000 acres in 1934-35 and 1,222,000 acres in 1933-34. The average for the last three years comes to 1,187,000 acres, which is about one per cent of the total acreage under wheat in India. The outturn was 476,000 tons in 1933-34,

505,000 tons in 1934-35 and 416,000 tons in 1935-36. The average comes to 466,000 tons. This is about two per cent of the total outturn.

Pusa 52 still remained the best wheat for the whole of Bihar. In varietal and manurial trials Pusa 165 in North Bihar and Pusa 113 in South Bihar gave slightly higher yields than Pusa 52, but these differences in yield were not statistically significant.

In the South Bihar Range, Pusa 52, due to its high-yielding and rust-resisting capacity, is increasing in popularity and its cultivation is steadily extending. It is decidedly better than the local varieties but has been surpassed by Pusa 101 during the last two years.

In South-East Bihar Range, Pusa 4 gave higher yields than Pusa 111 and Pusa 113 in the early series. The differences, however, were not significant. In the late series Pusa 52, Pusa 80-5, Pusa 101 and a local variety were compared and Pusa 101 stood first in yield. The difference between the yields of this and Pusa 52, which was second, was, however, not significant.

The result of an experiment to find out the effect of time of application of nitrogen to wheat indicated that there was no differential response in grain yield. The early dressings were found to help the formation of straw and the late ones the nitrogen-content of grain. This is an important finding and has a bearing on the quality of the crop. The early dressing also increased the number of tillers per plant.

Manurial trials with Pusa 52 showed that the application of P_2O_5 alone at 15 lbs. and 30 lbs. per acre had no effect on yield. Nitrogen alone at 15 lbs. per acre increased the yield, but a depressing effect was noticed when the rate was increased to 20 lbs. per acre. Nitrogen and P_2O_5 together at 15 and 30 lbs. respectively per acre gave an increased yield over the control. None of the manurial doses was found economical under the existing market rates of the manure and wheat.

In ORISSA, Pusa 52 out-yielded both Pusa 4 and Pusa 12. Here an early-ripening wheat is required. Trials with early varieties from Pusa and the Central Provinces will be started.

The Standing Wheat Committee of the Imperial Council of Agricultural Research, which met in July 1936, considered a number of topics of great importance relating to all aspects of wheat production. This included the registration of wheat varieties, the problem of wheat-breeding for the black soil areas, rust research in the Bombay-Deccan, the improvement of statistics of wheat production, etc.

During the year marketing survey work was commenced.

3. Cotton

THE year under review witnessed an increase in the area under cotton in India from 24,023,000 acres in 1934-35 to 25,138,000 acres. Favourable weather conditions at sowing time in the major cotton-growing tracts during 1935-36, coupled with the firm world price-level for cotton in the preceding year, resulting from the American cotton crop restriction programme, partly contributed to the increase in acreage. The condition of the growing crop during the year was, on the whole, fair and the estimated production of cotton was 5,728,000 bales of 400 lbs., giving an average yield of 91 lbs. per acre as against 4,858,000 bales with an average yield of 81 lbs. per acre during 1934-35. To sum up, the year saw the highest acreage since 1929-30, the largest crop since 1928-29 and the best average yield since 1927-28. The total crop accounted for by press returns and loose cotton received at mills was 6,208,000 bales during the year as against 4,830,000 bales during 1934-35.

The narrowing of the parity between Fine Broach and Middling American prices at Liverpool, which had set in during the latter half of last year as a result of the scarcity of better styles of Indian cotton, continued till the first half of this year, but, with the movement of the fairly large crop of the year, the parity of Indian cotton became attractive relatively to American during the latter half of the year. The exports of Indian cotton during the year amounted to 3,826,000 bales of 400 lbs. each, showing an increase of 711,000 bales over last year.

According to the statistics compiled by the International Cotton Federation, the world's total mill consumption of Indian cotton

during the year ending 31st July 1936 exclusive of Germany and Italy (for which figures are not available), slightly decreased to 5,393,000 bales from 5,414,000 bales during the preceding year. On the other hand, the consumption of Indian cotton in mills in India during the year reached 2,677,572 bales of 400 lbs. each and again established a new record, breaking the last year's record figure of 2,612,132 bales. The interesting feature of the consumption figures of the different centres of the mill industry during the last decade is that of the two principal centres of the industry, *viz.*, Bombay Island and Ahmedabad, the former has not yet regained its position of 1924-25 and the latter has continued the downward trend from the peak level it had attained in 1933-34; at other centres there has been a steady increase in the consumption of Indian cotton, notably in the Madras Presidency and Indian States, where consumption has doubled during the last decade. Further, perhaps as a result of economic forces, a tendency is noticeable towards the development of the cotton-mill industry in the heart of cotton-growing tracts.

The Indian Central Cotton Committee, incorporated in 1923 under the Indian Cotton Cess Act for the improvement and development of the growing, marketing and manufacture of cotton in India, recorded another year of progress and the work done on cotton in India by the Provincial and State Agricultural Departments, as well as that undertaken with the aid of funds provided by the Committee, is briefly outlined in the following paragraphs. The facilities provided by the scheme of publicity and propaganda undertaken by the Committee was also fully utilised by the Departments of Agriculture. The Committee maintained cordial relations with the Lancashire Indian Cotton Committee, the success of whose efforts towards the greater use of Indian cotton in the United Kingdom may be measured by the fact that imports of Indian cotton into the United Kingdom during the year ending 31st July 1936 exceeded half a million bales.

The Cotton Transport Act. The Cotton Transport Act, passed by the Government of India in 1923 at the instance of the Committee, enables Local Governments to prohibit the import of cotton

into any area within their jurisdiction. The Act was devised to prevent the import for mixing and substitution of inferior cotton into areas growing superior varieties, as such a practice tends to lower the reputation of the tract growing the superior cotton, which ultimately fetches lower prices. There was no change during the year in the number of areas notified under the Act in British India. The protected areas in Hyderabad, Indore, Sangli, Rajpipla and Chota Udepur, which are the only Indian States that have such legislation in force, also remained unaltered during the year.

Mention was made in the last review that a proposal was under consideration to fix the Mahi river as the northern boundary of the Nerbudda-Mahi protected zone in the Bombay Presidency. The Local Government have since accepted this proposal and have notified the change. It has been brought to notice that cotton could be imported at some places in the Surat protected zone as a result of the exclusion of certain stations on the Tapti-Valley Railway lying in Baroda territory both from the Bombay and Baroda notifications. The question of including them was under consideration during the year under review, and the omission was rectified.

The Local Government accepted the proposal for the reservation in Sind of a compact block south of the Jodhpur Railway of 300,000 acres for long-staple cotton. This raised the question of the application of the Cotton Transport Act to the proposed block to prevent the importation of *kapas* from outside the area for purposes of mixing. The absence of natural boundaries around the cotton-growing areas and the lack of regular routes of communications in Sind would, it was felt, make the enforcement of the Act both costly and difficult, but should at a later stage it be found that inferior seed is imported into Sind for sowing, necessary action will be taken. Efforts are now concentrated on ensuring an adequate supply of pure seed of the desired variety for the compact block.

In Madras the restrictions in the two protected areas worked satisfactorily during the year.

During the year the Narsingpur Sub-division was included in the protected area of the Central Provinces with the object of preventing the import of Bengals cotton for purposes of mixing.

Consideration of the question of the removal of restrictions on the import of all but *Deshi* Mewadi cotton into the Holkar State during the year revealed that Bengals cotton from one of the Punjab States was being imported into the Holkar State for purposes of mixing. As a result, the whole question is being re-considered by the Durbar.

In order that the object underlying the measures described above may not be nullified, it is essential that they should be reinforced by similar measures to eradicate the infection, if any, already present within a protected tract. Besides the Madras Presidency where such a measure has been in operation since 1932, legislation has been introduced in the Bombay Presidency, the Baroda State and the Central Provinces to maintain the quality of cotton within specified tracts.

The enforcement of the Madras Cotton Control Act of 1932, prohibiting the cultivation and mixing of Pulichai (*G. neglectum*) cotton and its sale, was extended for three years from 12th July 1935. The strict enforcement of the provisions of the Act in the Madura, Ramnad and Tinnevelly districts in the preceding years has presumably had a good effect as it has reduced the area sown to Pulichai cotton.

The situation created by the rapid spread in the Surat tract of Goghari cotton, an inferior variety, threatening the reputation of 1027 A L F to the detriment of the cotton growers of the tract, resulted in the passing of the Bombay Cotton Control Act in November 1935 prohibiting the cultivation, mixing or possession of Goghari cotton. It is hoped that this piece of legislation will go a long way towards improving the quality of cotton of the Surat tract and that the benefits to the grower expected from the Act will soon be realised.

As Goghari was spreading also in the Baroda State whose territory is interlaced with British Gujarat, the Baroda Durbar, by

notification, applied the provisions of the Bombay Cotton Control Act with slight modification to its own territories.

To eradicate Garrow Hill cotton, a coarse and inferior but prolific variety whose rapid spread in the Central Provinces and Berar was threatening the reputation of the superior cotton grown there, legislative measures have been passed, prohibiting the cultivation of Garrow Hill cotton in the Central Provinces.

Improvement of cotton marketing. Side by side with the measures for the improvement of the quality of cotton in India, the Committee has directed its efforts towards the prevention of malpractices such as watering, false-packing, etc. As a result of the passing of the Indian Cotton Ginning and Pressing Factories Act, 1925, and similar legislation in Indian States, it is now possible, by means of press marks on cotton bales, to trace the original ownership of the cotton. Whilst, however, this procedure does not prevent malpractices, it at least serves as a check and enables the trade to protect itself to some extent.

The above Act is, however, ineffective against such malpractices as watering and adulteration of cotton and the Committee has accordingly been agitating for an amendment of the Act with a view to introduce a system of licensing gins and presses whereby such factories would be required to take out licenses, as a condition precedent to their working, which were liable to withdrawal or suspension, should the factories be found guilty of malpractices. The year under review witnessed the enactment of the necessary amending legislation by the Bombay and Central Provinces Governments. Legislation of this nature by the Central Government was considered to be impracticable. The Amending Acts, passed by the Local Governments referred to, make it obligatory on all cotton ginning and pressing factories, situated in areas to which the Act may be applied, to take out licenses and prohibit watering, mixing, or admixture of cotton. It was originally intended to apply the Bombay Amendment Act to Sind very soon after its passing, but due to delay in framing the necessary rules by the new province of Sind, the Act could not be enforced during the revenue year 1936-37. The application of the Amendment Act to

parts of the Bombay Presidency is under the consideration of the Local Government. The Central Provinces Act extends to the whole of the province and will be in operation as soon as the rules are framed. The Punjab Government have deferred consideration of the question of introducing a similar measure, pending the working of the respective Acts in the Central Provinces and Sind and the Bombay Presidency. Among Indian States, legislation for the licensing of ginning and pressing factories is already in force in the Indore and Hyderabad States.

During the year five cases of excessive watering of cotton were reported by the East India Cotton Association and two by an exporting firm. As a result of a complaint received regarding the unsatisfactory ginning and pressing of Punjab-American cotton, a circular was issued by the Director of Agriculture, Punjab, to the gins and presses to raise the standard of ginning and pressing of cotton. As reports were received that mill-fly, droppings, cotton waste and even old crop cotton were being mixed with good cotton in Khandesh, the Committee passed a resolution requesting the Government of Bombay to extend the Cotton Ginning and Pressing Factories (Bombay Amendment) Act to East and West Khandesh and other tracts of the Bombay Presidency, particularly in view of the fact that the Central Provinces Government had already passed similar legislation. Since the Bombay Act, as at present worded, does not prevent the mixing of cotton waste with cotton, the Bombay Government had also been approached to take in hand the necessary amendment for this purpose.

The establishment of regulated cotton markets is another direction in which improvement in the marketing of cotton is attempted. There are three regulated cotton markets in the Bombay Presidency, two in the Central Provinces and one in the Madras Presidency. The Central Provinces Legislative Council passed during the year a law empowering the Local Government to establish regulated cotton markets even without the consent of the local bodies concerned, as this procedure often resulted in considerable delay. It is hoped that the new law will lead to the more rapid establishment of regulated cotton markets in that province. In the Sangli

State the original Huzur order regulating the sale and purchase of commercial crops in the State continued to be in force. There are several cotton markets in the Hyderabad State to which the Hyderabad Agricultural Markets Act has been applied.

Further progress was made during the year in the introduction of universal standards for Indian cotton in the country. As in the previous year, standards for different varieties of cotton were passed by the Standards Sub-committee of the Indian Central Cotton Committee. It is noteworthy that the Karachi Cotton Association has decided to accept the universal standards of the Committee as the basis for its standards. Further the Standards Sub-committee of the East India Cotton Association has recommended to the Board of Directors of the Association that the universal standards of the Committee should be adopted as the basis for the preparation of the official standards of the Association.

Protective measures against pests and diseases. The restrictions imposed by the Government of India on the import of American cotton and foreign cotton-seed with a view to preventing the introduction of foreign cotton pests through such imports, remained unchanged during the year.

In the Madras Presidency the Pest Act continued to be enforced in respect of the stem-weevil (*Pempheres affinis*) and the Pink Boll-worm (*Golechea gossypiella*) which attack Cambodia and Pachanadan cottons in the Salem, Trichinopoly, Madura, Ramnad and Coimbatore districts. The eradication of Cambodia and Pachanadan cotton plants between two successive crops proceeded smoothly and, with a few exceptions, was completed by the specified date.

Propaganda in the Surat and Broach districts for the removal of cotton stalks and stubble before May to create a close season against the rapid multiplication of the Spotted Boll-worm was conducted on a wide scale with the aid of funds provided by the Committee and met with good response.

Cotton statistics. The improvement of the accuracy of the official cotton forecasts in India has been receiving the close attention of the Committee, through its Cotton Forecast Improvement Sub-committee specially constituted for the purpose. A practical

step in this direction was taken by the Committee in 1934 with the financing of a scheme for the improvement of the cotton forecasts of the Bombay Presidency and Sind (including Indian States) for five years. The investigation has already resulted in the discovery of several sources of errors in the different factors involved in the compilation of cotton forecasts and the necessary remedial measures have been adopted.

Some of the enquiries undertaken into the village or extra-factory consumption of cotton in the different provinces and States have been completed, but as one or two other reports are still under examination, the question of framing an all-India estimate is held up.

The Committee continued to publish monthly statistics of Indian cotton consumed in spinning mills in India and of loose cotton received at mills in the major cotton-growing provinces of British India. The varietal statistics of receipts of cotton at mills in India during the season, of stocks of Indian cotton held by the trade and mills at the end of the season and of exports of Indian cotton during the season were as usual compiled and published in leaflet form. In the statistical leaflet relating to the cotton crop of 1935-36 classified according to staple length, published during the year, an innovation was introduced by showing Government estimates side by side with trade estimates.

Cotton research. The problem of cotton research on the agricultural side forms part of the normal duties of the Agricultural Departments in the Provinces and States but the resources of the Departments are considerably strengthened by grants made by the Committee to enable them to undertake investigations on botanical, physiological, entomological, mycological and agronomic problems in their respective cotton areas. In addition, the Committee maintains the Technological Laboratory at Matunga, while the Institute of Plant Industry, Indore, is subsidised by the Committee to a large extent to function as a central agricultural and research station for cotton.

Technological Laboratory. The resources of the Laboratory continued to be utilised as in the past by agricultural officers in

assessing the spinning value of their new strains. Spinning mills utilised to a much greater extent than in the past the facilities afforded by the Laboratory for the testing of their samples or the solution of their problems. The results of tests on trade varieties of Indian cotton, supplied by the East India Cotton Association, the Ahmedabad Millowners' Association and the Bombay Millowners' Association and those on Standard Indian Cottons supplied by Agricultural Departments, were published as usual in the form of Technological Circulars. A new feature introduced during the year was the compilation of all the circulars on trade varieties of Indian cottons in the form of a Bulletin under the title " Technological Reports on Trade Varieties of Indian Cotton " corresponding to the Bulletin on Standard Indian Cottons. Other investigations of interest completed during the year were the effect of different degrees of compression on the spinning quality of cotton, the effect of artificial watering on the spinning quality of cotton and the deterioration of cotton stored in the open and in sheds at Karachi. A brochure entitled " Cotton Research in India ", being an account of the work done by the Laboratory during a decade of its existence, was published during the year.

The question of the possibility of utilising short-staple Indian cotton for the manufacture of artificial silk was taken up during the year and preliminary work on the cellulose content of Indian cottons was also begun. Further work is in progress in collaboration with the Industrial Research Bureau.

The Institute of Plant Industry, Indore, completed its twelfth year of life during the year. The programme of work of the Institute covers the general botany, physiology and genetics of cotton and in addition several agricultural investigations dealing with the cultivation of cotton and other crops were carried out. During the year the writing-up of the survey of Nimar and Malwa cottons was nearly completed and the promising plant-breeding material collected during the survey has been included in the programme of work at Sriganganagar and Indore. A preliminary study of the indigenous and introduced cottons of Kathiawar was undertaken at the instance of the Indian Central Cotton Com-

mittee in connection with the improvement of the quality of Dholleras cotton. The survey showed that the range of variation in Wagad is very much greater than in Matheo and that if a *herbaceum* cotton is ever to be re-established in the present Matheo tract, it will have to be an early type bred by crossing Wagad with an early *herbaceum*, probably from Iran or Afghanistan. In this connection one of the botanical assistants was sent to Iran during the year for the collection of promising early *herbaceum* cottons. The work in the genetics section included studies on the fundamental genetic basis of lint hairs, interspecific hybridisation and on genetic variance. As usual, experiments on cotton physiology, pathology and agronomy were also in progress. As regards the improvement of the quality of Malvi cotton, Malvi 9 has proved to be a great advance in quality over the local Malvi crop, and in order to accelerate its multiplication and extension, the nucleus of a seed-extension scheme has been formed by the distribution of the seed in five villages in the vicinity of the Institute.

BOMBAY. The Khandesh Cotton Breeding Scheme at Jalgaon made further progress during the year in the evolution for the Khandesh tract of new strains of cotton superior to Banilla and local *Neglectum roseum* and resistant to wilt. The three promising strains of *Neglectum verum*, *viz.*, NV 57-7, N V 56-3 and N V 56-17 referred to in the last review were again tested for yield in replicated plots. Of the three selections, N V 56-3 spins up to 40's and is more drought-resistant, more vigorous in growth and gives higher ginning outturn than N V 56-7, the next best. The problem of evolving a completely wilt-immune strain, however, still remains to be solved, and promising selections are under severe test. The Broach Cotton Breeding Scheme has for its object the breeding of suitable types of cotton for the Nerbudda-Mahi zone with wilt-resistant, heavy-yielding, good-spinning and high-ginning qualities to replace the local mixture consisting of a large percentage of Goghari, a rough and short-stapled variety susceptible to wilt but with a high ginning outturn. Breeding work is in progress with B D 8 and N S 12 as basic stocks. It may be mentioned that B D 8 possesses all the necessary qualities except in respect of

ginning outturn. Of the single-line selections made during the last three seasons, N S 49 has proved to be wilt-resistant in the field besides possessing other desirable characters. Out of the crosses, the cross B D 8 with G A 26 (F_5) has given some very promising selections in respect of staple, silkiness and ginning outturn, and some of these are either free from wilt or show only a small percentage of wilt. N S 49 and the cross B D 8, G A 26 (F_5) will be tested for yield and spinning quality in comparison with B D 8 and N S 12. An examination of the possibility of evolving a suitable medium or long-staple cotton for the short-staple tract of Bijapur, where rainfall is precarious, revealed that dry-farming research in cotton cultivation was likely to lead to a solution of the problem and the Committee has accordingly sanctioned a small grant for one year in the first instance for the inclusion of experiments on cotton in the dry farming scheme at the Bijapur sub-centre financed by the Imperial Council of Agricultural Research. As detailed elsewhere, a survey of the cottons of Kathiawar was carried out during the year with the aid of funds provided by the Committee and, as a result, a scheme for the improvement of the cottons of the Dholleras tract—an extensive area to which little attention has been paid in the past—has been sanctioned by the Committee.

SIND. Botanical research in Sind has been mainly directed towards the selection of the most suitable varieties of long, medium and short-staple cottons under Barrage conditions and the study of their economic value to the cultivator. As a result of further tests during the year, Sind N R (27 W N) was found to be significantly superior in yield to the rest, while 285F-2, Sind-American surpassed in yield Sind Sudhar cotton only. Considerable attention has been devoted at Sakrand to the evolution by selection of an improved strain of Sind-American cotton which can withstand jassid attack and red-leaf disease under conditions of late sowing. Two new 4F selections, *viz.*, 4F-98-1 and 4F-98-4, were tested during the year, and these, besides being immune to jassid attack and red-leaf disease, gave high yields though the staple was somewhat reduced owing to seasonal conditions, 4F-98-4, the more promising of the

two, possessing a staple length of 24·5 mm. and a ginning percentage of 33·7, has been multiplied on a small field scale. With the object of exploring the possibility of evolving strains superior to Boss 111-16 and Sea Island 2-4, the high-quality cottons selected for Sind, comparative tests with acclimatised African and Sudan varieties were continued during the year. Work on breeding by hybridisation a hardy jassid-resistant long-stapled and high-yielding cotton is in progress. Physiological work in Sind, which is financed by the Indian Central Cotton Committee is dealt with under *Plant Physiology.* Manurial experiments have proved again that the application of manure to cotton is profitable in Sind when compost alone is applied at fifteen cartloads per acre or when with an initial application of compost before sowing at 7½ cartloads per acre, ammonium sulphate is applied at the rate of fifty to one hundred lbs. per acre when the crop is 1½ to 3½ months old.

PUNJAB. Reference was made in the last review to the evolution of a new American strain 43F to replace 4F ; trials on a field scale during the year have confirmed its superiority over 4F, 289F and L S S. It is expected to extend over 25,000 acres in 1936-37. 38F, another promising strain of American cotton, is gaining popularity in the drier parts of the Province where jassid is not a serious pest. Yet another American strain 47F, which is under final test, appears to be superior even to 43F in respect of yield, ginning outturn and hardiness and is capable of spinning 50's warp counts. Work on the improvement of *deshi* cotton was continued during the year, and 39 Mollisoni again stood well in field trials. As a result of the hybridisation work started in 1930 by crossing 15 Mollisoni with Million Dollar (a Chinese variety with medium lint) and the study of their successive generations, a strain called Jubilee Cotton has been evolved, which spins from 16's to 18's counts against the 6's to 8's of Mollisoni.

The Punjab physiological scheme for the study of the periodic failure of American cottons is mentioned under *Plant Physiology.*

The investigation of root-rot in the Punjab, where the annual damage done to cotton by this disease is estimated at about

Rs. sixteen lakhs, was started in 1932. There is no type of cotton, *deshi* or American, in the Punjab, which can resist the attack of root-rot. The disease is practically harmless on any cotton grown under rainfed conditions and its activity seems to be directly proportional to the number of irrigations or the amount of moisture in the soil. The physiological investigations of the two causal organisms of the disease, *viz.*, *Rhizoctonia bataticola* and *Rhizoctonia solani* indicate that the application of ammonium salts might prove useful to minimise the disease, but the results require further confirmation.

As regards the investigations on cotton pests in the Punjab, the White Fly Scheme, started in 1931 with a view to study the life-history of the White Fly (*Bemesia gossypiperda*), a small sucking insect that does damage to cotton and other crops, came to a close during the year. The work of the year again confirms the results already obtained on the seasonal history of the pest. The most active period of the pest is from May to September when it migrates from cotton to alternative host plants and various weeds on which it passes the winter. From March to May it extends to cultivated cucurbits and ratoon cotton and goes back thereafter to the new cotton crop. Infestation was found higher again this year on Mollisoni than on Punjab-American types and was reduced to some extent when ammonium sulphate was applied to the crop early in the season. Chemical analysis of the affected and unaffected plants showed difference in their nitrogen-content as well as in the percentage of nitrogen transported from the vegetative to reproductive organs. The final report on the scheme is being written up. Further investigations on the economic aspects of the Spotted Boll-worm, which predominates in the Canal Colonies and western Punjab, showed that in the Canal Colonies cotton sprouts from the previous year's stumps were the only source of food supply of the Boll-worm for about six weeks from the middle of April, while in the central, south-eastern and sub-montane regions, in addition to cotton sprouts, host plants particularly *Malva parviflora*, *Abutilon indicum*, and *Malvestrum tricuspidatum* serve as breeding grounds in the off-season. It is thus evident that any clean-up scheme for up-

rooting cotton stalks and stubble to avoid the Boll-worm pest is not likely to yield satisfactory results unless the other host plants are simultaneously removed.

The agronomic work on watering, spacing and manuring of cotton was carried out as usual and interesting results have been obtained, which are now being translated into practice.

UNITED PROVINCES. The cotton survey in the Rohilkhand and Bundelkhand divisions and adjoining Indian States carried out during the last three years has resulted in a good collection of plant-breeding material, the best of which is being grown for the study of economic characters of the individual plants.

The control of the Pink Boll-worm on a field scale, started in 1925, was continued during the year in the Aligarh and Hardwar districts. The economic importance of this pest may be gauged from the fact that besides the reduction in the yield per acre caused by the pest, the value of the harvested crop is also lowered due to the damage to lint by Pink Boll-worm infestation. The results of the observation plots during the year have shown that control measures, by the supply of heat-treated seed for sowing over an area of about 50,000 acres have resulted in increasing the gross value of the crop by ten lakhs of rupees. The United Provinces Cotton Pest Control Bill, which has recently been passed into law, gives legislative sanction to the introduction of control measures which previous research has shown to be necessary to minimise the ravages of the Pink Boll-worm.

CENTRAL PROVINCES. The botanical work in the Central Provinces is financed by the Indian Central Cotton Committee, the chief object being the evolution of strains superior to Verum 262 in respect of yield, spinning quality and hardiness to withstand adverse climatic conditions. The object has more or less been achieved and it is only a question of two or three years more before Verum 262 is completely replaced by three superior strains V-434, late Verum and Verum 438, which satisfy the needs of the different cotton-growing areas of the Central Provinces and Berar. The outstanding feature of the year has been the success achieved by V-434 under varied conditions of soil and climate. Besides being

prolific, wilt-resistant, quick in forming buds and setting bolls, V-434 combines good lint characters and high ginning percentage and spins up to 32's standard warp counts. Though late Verum suffered considerably during the year owing to the early cessation of the monsoon and the absence of late rains, its suitability to areas where the monsoon lasts till late in the season was clearly demonstrated by its high yield of 944 lbs. of *kapas* per acre at the Nagpur farm, where fortunately a stray thunder shower fell in October. Late Verum combines all the characters of V-434 and spins up to 36's standard warp counts. V-438 is specially suitable for soils of lighter descriptions and its lint is as good as V-434. The improved American strains, Buri A K Special and No. 107, have done well again, while work on Bani 306 and E B 31 (*indicum* types) continued on the lines of previous years.

Physiological work on cotton included daily observations on growth, flowering, bud and boll-shedding and boll-opening and a study of the influence of climatic and other factors on the development of the plant. Experiments dealing with the various cultural and manurial treatments and the optimum conditions of sowing were continued.

The entomological work in the Central Provinces and Berar is financed by the Indian Central Cotton Committee, the object being the survey of the cotton boll-worm pest in the Central Provinces and Berar with a view to ascertain its incidence and method of carry-over. Three types of boll-worms, *viz.*, the Spotted Boll-worm (*Earias fabia*), the Pink Boll-worm (*Platyedra gossypiella*), and the cotton boll-worm of America locally known as the Gram Caterpillar (*Heliothis chloridea obsoleta*), cause much damage to the cotton crop of the province. As the Pink Boll-worm prefers mature bolls to buds and tender bolls, and as its maximum population is reached only in January, when all the cotton pickings in the Province are over, the damage done by this pest is not so serious as that of the Spotted Boll-worm and the Gram Caterpillar, which attack buds and young bolls. The results of the investigation have shown that the position of the boll-worm pest in the Central Provinces and Berar is about the same as in Gujarat and that the only practical

way of controlling it is by the adoption of clean-up measures similar to those advocated for Gujarat, *viz.*, the up-rooting of cotton stalks and stubbles and the eradication of alternative host plants as early as possible after the harvest of cotton.

MADRAS. During the year field-scale trials on three strains of Cambodia cotton showed that strains 920 and 1267 were better than Co 2. The results of crossing Co 2 with South African cotton indicated the possibility of strains yielding as much but earlier than Co 2 by one month, which would enable the ryots to adopt the necessary close period between successive crops of cotton in the Cambodia tract. At Koilpatti K P T-1 was found to be better than A 10 in respect of yield. Comparative trials under dry conditions were made at Guntur on four strains of Cambodia cotton, while at Hagari *inter se* crosses between H 1 and 1162, and H 1 and Surat 1027 A L F, were effected with a view to evolve a better strain than H 1. Trials at Nandyal indicated that Gadag No. 1 was better than N 14 both in yield and ginning percentage. Varietal trials on "Poonam" land in Malabar indicated that Karunganni 546 would be a very suitable substitute for the coarse short-stapled cottons of the tract.

Four research schemes financed by the Indian Central Cotton Committee were in operation in the Madras Presidency during the year. The *Herbaceum Scheme*, which has for its object the evolution of a strain as good as Karunganni in lint qualities and as hardy as Uppam showed further progress during the year. Of the hybrid strains 4803 and 4714, which were found to be promising last year, the latter has once again proved very satisfactory and that too in one of the most droughty and trying years experienced within the past two decades. This strain, while being superior to Karunganni in yield and equal to it in spinning performance, has been found to be satisfactory from the point of ginning out-turn, drought resistance and ability to withstand untimely February rains. As the hybrid strain has, however, a narrow leaf resembling Roseum, attempts are being made to isolate broad-lobed mutants found in this type

The Nadam Cotton Breeding Scheme, having for its object the evolution of a suitable annual type of cotton to replace Nadam cotton in the Salem and Coimbatore districts, made further progress during the year and promising strains are under observation.

The physiological work under the *Pempheres and Physiological Scheme* is mentioned under *Plant Physiology.*

The Parasitologist employed under the scheme made a survey of all important cotton tracts and found that *Pempheres* prevails as a pest of cotton in the Ramnad, Coimbatore and Tinnevelly districts and also as a pest of a vegetable—*Bendi* (*Hibiscus esculentus*)—in the Malabar district, and that parasitisation on the weevil is only to the extent of about 4·7 per cent. One of the parasites is found in large numbers and is capable of destroying the weevil by stinging. Attempts are being made to multiply this parasite in large numbers with a view to liberate them next season.

Work at Koilpatti on the bud and boll-shedding of cotton was continued with a view to obtain selections which would shed least during the rains in February and the results showed that a few selections not only shed their bolls in small quantities but yielded more taking advantage of the rains in February.

Work on the *Fodder Cholam Scheme,* to ascertain the causes of the harmful effects of *cholam* (*Andropogon Sorghum*) as against *cumbu* (*Pennisetum typhoideum*) on the succeeding crop of cotton, and to devise remedial measures therefor, continued during the year, but, due to the failure of the monsoon, many of the trials gave inconclusive results. Experiments on spacing, manuring and growing *cholam* mixed with pulses were also in progress. The studies on base exchange in soil confirmed the inference that sodium ions increased in quantity as a result of growing *cholam.*

BENGAL. The work on the improvement of the commercial grade of *cernuum* cotton under the *Comilla Cotton Scheme,* financed by the Indian Central Cotton Committee, consisted of observations on selected strains obtained in the previous year. Experimental trials with Punjab-American 289-F and Cambodia cotton were also made during the year in the districts of Midnapore and Dacca respectively.

BURMA. Experimental work on cotton was carried out as usual on the Mahlaing Central Farm and at Allanmyo. At the Mahlaing Farm the improved Wagad strain C/19 and two hybrid strains L11 × W6, C/19 × W5 were tested for yield against ordinary Wagale. The results confirmed that the hybrid strains were superior to C/19 in yield and quality. Fertiliser tests showed that fifty lbs. Nicifos No. 2 per acre could be safely recommended. Experiments on inter-cultivation gave interesting results.

HYDERABAD. The work during the year under the Botanical Research Scheme financed by the Indian Central Cotton Committee mainly consisted of testing old strains and making new single plant selections from Gaorani mixture and short-staple varieties. The object of the scheme is to replace the present mixture of Gaorani cotton in the Hyderabad State by a few prolific, high-ginning uniform types with good spinning qualities. Of the twenty-nine Gaorani strains tested during the year, four, *viz.*, G 4-B, G 4-B4, G 4-B5 and G 58-A-1 are likely to prove satisfactory, while none of the new short-staple strains came up to the level of Haveri 3. G 4 and G 6, which gave very promising results in comparative tests during the past three years, were again tried side by side with Gaorani mixture as control in cultivators' fields. G 4 failed in the test, while G 6 fared better. G 4 and G 6 were also tested on a commercial scale on 900 and 500 acres respectively in Nanded district and here again G 6 gave satisfactory yields, while G 4 failed. G 4 and G 6 spin up to 33's and 40's warp counts respectively. *The Cotton Survey Scheme* came to a close during the year and the final report thereon is being written up. A scheme has been sanctioned by the Committee during the year for the improvement of the Kumpta cotton of the Hyderabad State.

The Pink and Spotted Boll-worm Scheme was started with the object of ascertaining the actual damage done by the boll-worms in the Godavary valley and their mode of carry-over from season to season, as well as to formulate control measures. The work of the year was more or less a repetition of what was done last year. The results have shown that the Spotted Boll-worm is practically never absent, the maximum incidence being attained in December.

As regards the Pink Boll-worm, it makes its first appearance in June, reaching its maximum increase in January-February. The method of carry-over of the two boll-worms is the same as elsewhere in India, with the difference that, unlike in the United Provinces, the Pink Boll-worm in the Hyderabad State does not survive in stored seed.

BARODA. During the year, a survey of Goghari cotton was undertaken to find out the extent of its mixture in the cotton tract of the State and the survey on about 3,200 acres revealed that its incidence was about 1·6 per cent on the average. As a result of investigations on the root-rot disease of cotton in the Baroda State, breeding work is in progress towards the evolution of resistant strains.

MYSORE. The *Doddahathi* (*American*) *Cotton Scheme* was sanctioned in February, 1935, for the purpose of breeding suitable types from the local Doddahathi or American cotton, resistant to Red Leaf disease, which is an impediment to the expansion of this crop in the Irwin Canal area in the State. The work of the year at the Central Laboratory, Bangalore, indicates that Co 2 (Cambodia), Gadag No. 1, 295-F-21, Ashmouni-37 and Uganda varieties are more susceptible to Red Leaf than 4F-98, Sea-Island, Co 1, Boss III-16 and *Arboreum* varieties and crosses between Ashmouni and Peruvian, 4F-98 and Peruvian, and Sakel and Peruvian. Sowing tests on the Irwin Canal farm also tend to confirm the existence of a relation between the disease and the time of sowing. Work on breeding high-yielding and better-spinning types was also in progress.

BIKANER. As a result of the scheme sanctioned by the Committee with the object of obtaining a superior type of cotton for the Gang Canal area, it has been decided to multiply and distribute seed of Cawnpore 520, which has been found to be the profitable variety for the tract. Cawnpore 520 gives the best results when it is sown in the middle of May, though the sowings can be extended till the latter part of June without any loss in yield; June sowings, however, slightly lower the ginning out-turn. Also this strain does not require much watering and gives normal yields with as few as four suitably adjusted irrigations.

Dissemination of pure seed of improved varieties.—In order to ensure that the results obtained from botanical and other research work on cotton are not lost, a system of multiplying and supplying pure seed of improved varieties has been organised with the aid of funds provided by the Committee. There were several seed schemes in operation during the year in the different Provinces and States. In the Bombay Presidency schemes were in operation for the extension of Jayawant and Gadag I varieties around Hubli, Gadag and Athani, Banilla in Khandesh and the Deccan Canals, 1027 A L F in the Surat tract and B D 8 in the Broach tract proper. In Sind, seed of 4F-98 and Sind Sudhar (289F-1) is being extended as rapidly as possible. A combined scheme for the extension and marketing of Verum cotton was in operation in the Central Provinces and Berar, financed by the Indian Central Cotton Committee. In the Madras Presidency the multiplication and distribution of pure Co 2 seed is being carried out, while in the United Provinces C 520 and C 402 are being extended. Two schemes were working in the Hyderabad and Baroda States, the former for the extension of 1027 A L F and the latter for Jayawant cotton. The total area under improved strains of cotton during 1935-36 so far as could be ascertained was 4,057,000 acres, forming 16·1 per cent of the total area under cotton. Of the area under improved varieties no less than 3,143,000 acres were under long and medium-staple cotton.

Co-operative cotton sale societies.—The number of Co-operative Cotton Sale Societies working in the Bombay Presidency during the year declined to twenty-seven from thirty in the previous year. The quantity and value of cotton (ginned and unginned) handled by the societies amounted to 400,000 maunds* and Rs. 22,00,000 respectively, against 700,000 maunds and Rs. 57,00,000 during 1934-35. The fall in the value and quantity of the total sales during 1935-36 is partly due to the winding up of the Haveri Cotton Sale Union during the year, coupled with the fact that the sales of the previous year pertained to the *rabi* crops of two seasons. The societies continue to make steady progress and have established their reputation as

* 1 maund = 82⅔ lbs.

effective agencies for improving the quality of cotton grown and for securing better prices to the growers. In the Madras Presidency there were seven societies working during the year which dealt largely in cotton as against six in the previous year. The total value of cotton handled by the societies amounted to Rs. 10,00,000 during the year 1936 ; this sum includes the business done by the Tiruppur Trading Society and Udumalpet Trading Society for the first six months only. In the Central Provinces there were two Co-operative *Adat* Societies dealing largely in cotton, and they handled seventy-five *bhojas* and 273 candies of ginned cotton and 59 candies of unginned cotton of the aggregate value of Rs. 32,000. There are no co-operative societies in the Punjab purely for the sale of cotton, but the ' Co-operative Commission shops ' also deal in cotton along with other produce. Nineteen such shops were working during the year and handled 320,000 maunds of ginned and 26,000 maunds of unginned cotton of the aggregate value of Rs. 23,00,000 against seventeen shops with a turn-over of Rs. 21,00,000 in 1934-35. In the Baroda State there were twelve active societies during the year which handled about 5,000 *bhars* of cotton of the value of Rs. 5,00,000. There were no sale societies dealing purely with cotton during the year in the Mysore State, but there was one Co-operative Credit Society which undertook the collection of cotton grown by its members and sold such cotton to the extent of about 4,000 maunds.

4. Sugarcane

WEATHER conditions for the sugarcane crop in India for the year 1935-36 were reported to be good on the whole. The area under this crop in the various provinces of India and the Indian States was estimated according to the Final General Memorandum issued by the Director-General of Commercial Intelligence and Statistics, Calcutta, to be 4,007,000 acres, as against 3,477,000 acres in the previous year, or an increase of fifteen per cent. The total estimated yield of *gur* stood at 5,909,000 tons compared with 5,109,000 tons last year, or an increase of sixteen per cent.

The total quantity of cane crushed during the season 1935-36 was 9,801,748 tons as against 6,672,000 tons in the previous season. The production of sugar direct from cane in India totalled 912,100 tons during the season 1935-36 as against 578,115 tons in 1934-35. The average extraction for the whole of India shows a very substantial increase, the figure being 9·29 per cent for 1935-36 as against 8·66 per cent for 1934-35. In Bombay the majority of factories had recoveries of over ten per cent. The majority of factories in the United Provinces had recoveries of nine per cent and over. In Bihar and Orissa the majority of factories had recoveries of 8·5 per cent and over.

The year 1935 continued to be unfavourable for the *gur*-refining industry. *Gur* prices were much higher, while sugar prices were only a little higher than in the previous year. The increasing competition from cane factories coupled with an unfavourable price relation between *gur* and sugar have been responsible for the decline of the *gur*-refining industry. Only four out of the forty-nine cane sugar factories which are at present equipped with plant for refining *gur* and nine out of eleven refineries, making a total of thirteen* worked during the year 1935 as against sixteen in the previous year and twenty-seven in 1933. Out of the six factories that refined *gur* during the season in the United Provinces, two are cane sugar factories which also manufacture sugar direct from cane. Two factories in the Punjab refined *gur* during the season, both being refineries. Out of five factories that operated with *gur* in Madras in 1935, two also crushed cane. The production of sugar refined from *gur* in India during the season 1935 amounted to 39,103 tons as against 61,094 tons during the season 1934, or a decrease of 21,991 tons. Out of the total production of sugar refined from *gur* during 1935, 35,528 tons were manufactured by factories which are purely refineries, while 3,575 tons were made by cane factories equipped with auxiliary refining plant. An analysis of the average recovery percentage of sugar from *gur* for factories in different provinces in India during the season 1935 showed that the highest recovery for

* One refinery in the United Provinces which worked during the season 1935 has not submitted returns. The figures, therefore, relate to the twelve factories that have submitted returns.

the season was 63·8 per cent as against 68·3 per cent during the preceding season. The average recovery percentage both for the United Provinces and for all-India has, however, increased this year to 56·58 per cent and 57·83 per cent as against 55·16 per cent and 56·96 per cent respectively during the season of 1934, while that for the other provinces has gone down slightly to 59·74 per cent as against 59·97 per cent during the preceding season.

(*a*) *Breeding of early and late canes.* The SUGARCANE BREEDING STATION AT COIMBATORE continued to evolve further improved hybrid cane varieties. On the accumulated experience of past years, parents are now available for introducing into the hybrids such valuable characters as ' vigour of growth ', ' earliness ' and ' good habit '. Though a fair number of ' early ' canes have been bred for growing under sub-tropical conditions, many of these do not give satisfactory tonnages. One main item in future hybridization programme is reported to be the combination of ' earliness ' with good tonnage. Co 508 is proving useful for introducing ' earliness ' and satisfactory sugar values. ' Late ' canes are equally desirable for extending the crushing season of the factory and Co 331, which is late with a high tonnage, is proving useful as such in certain parts of India, *e.g.*, south-east Punjab, the whole of the United Provinces and part of Bihar. The main problem would appear to be to evolve ' late ' canes which, even under the severe conditions of North India, would not deteriorate in quality or show increased fibre contents. *Saccharum robustum* has been used in America and Australia to breed types with uniform canes. It was employed as parent during the year under review at Coimbatore as well.

(*b*) *Breeding of thick canes.* For the breeding of thicker class of canes for India the following items of research, among others, were attended to :—(1) flowering habits of certain varieties, (2) pollen studies, (3) study of sterility, (4) bristles as possible adaptation against mosaic, and (5) germination in thick cane seeds. Over fifty crosses were made and the number of seedlings raised was over 200,000, the largest ever attempted at the Thick Cane Area. The choice of P O J 2878 and others as parents has been justified

by the performance of thick Co canes—Co 419 and Co 421. The former (Co 419) has out-yielded the famous Java cane P O J 2878 in certain experiment stations in the Bombay and Madras presidencies and has also done well in the preliminary experiments in Assam and Burma. The latter (Co 421) was found to be easily the best cane at Karnal both in tonnage and analysis figures as compared with the standard cane Co 285 and other varieties. It has also done well in other experiment stations in the Punjab, United Provinces and Bihar.

(*c*) *Cyto-genetic studies.* In the cyto-genetic studies, one rather interesting phenomenon revealed is that, whereas there is a doubling of chromosomes on the mother side, in the case of certain crosses, such doubling does not occur in others. Progenies of comparatively simple types of *Saccharum spontaneum*, even when selfed, show wide variations in the morphological characters of the ligule and the bud. About half a dozen bud sports were obtained in Co 213 by multiplying and injuring the buds before planting. Certain of the Bihar types of *S. spontaneum* showed high sucrose and purities in the periodic routine analysis.

(*d*) *Performance of Coimbatore canes.* There has been an increase in the spread of Coimbatore canes and, besides the old ones, certain new canes are reported to have done well. Co 312 has proved superior to the old seedlings both in the Sarda and the North-east circles of the United Provinces. Co 331 is being developed in the United Provinces for wide cultivation as a 'late' cane. Co 270 and Co 301 have recently been released for commercial planting in Natal (South Africa). Co 290 is attracting attention in Australia as fodder cane and replacing the older Japanese types.

At the IMPERIAL INSTITUTE OF AGRICULTURAL RESEARCH, PUSA, the importation of new varieties of sugarcane from Coimbatore and their testing and multiplication were continued as in previous years. Experiment on tonnage yield with sugarcane varieties Co 213 and Co 331 was laid down according to Beaven's half-drill-strip arrangement with fifteen replications for each variety. The crop was allowed to stand over and harvested in March. The results showed that Co 331 was better than Co 213. The sixth

year's trial with sugarcane varieties Co 210 and Co 213 was concluded in favour of Co 210. The experiment was carried out as before in plots arranged according to Beaven's half-drill-strip method with twelve replications for each variety. The results of experiments on the spacing of sugarcane rows and arrangement of setts at planting with Co 210 have confirmed the conclusion reached before, *i.e.*, the spacing of 2½ feet is not advantageous as more setts are required. Further, the arrangement of ' eye to eye ' at planting with ordinary seed is advisable and ' end to end ' with good setts is equally sound.

The preliminary manurial experiments on sugarcane with silt and farmyard manure revealed the necessity of further trial on a properly designed layout. The manures were tried in paired plots according to Beaven's half-drill-strip method with twelve replications for each treatment. The usual dose of farmyard manure, fourteen tons per acre, was applied about two months before planting, and silt was also added at the same time, on an equal cost basis, at twenty-eight tons per acre. Though the results of two previous years indicated a better prospect for silt, it was, however, not maintained in the present year. A complex experiment was initiated during the year 1935-36 with eleven treatments (including a control) and with three standard varieties—Co 210, Co 213 and Co 331. The experiment was laid down in three " Randomised Blocks " with nine replications for treatment and thirty-three for variety. The effective area of each plot was 1/30 acre. The field was green-manured in *kharif* 1934. Treatments per acre were—(1) farmyard manure—ten tons, (2) village bulk manure (F. Y. M.) ten tons, (3) farmyard manure—fourteen tons, (4) cattle standings—fourteen tons, (5) river silt—twenty-eight tons, (6) tank soil—twenty-eight tons, (7) standard manure (forty lbs. N as rape cake and fifty lbs. P_2O_5 as superphosphate), (8) complete minerals (40 lbs. N as ammonium sulphate, 50 lbs. P_2O_5 as superphosphate and 40 lbs. K_2O as potassium sulphate), (9) superphosphate—75 lbs. P_2O_5, (10) ammonium sulphate—80 lbs. N and (11) no manure (control). In this experiment the superiority of farmyard manure and ' standard manure ' was established and on

the whole Co 331 gave better results than Co 210 which in its turn was found better than Co 213. Experiments on green-manuring with berseem on sugarcane ratoon was also continued. First ratoon was raised to see the residual effect of manures applied to various plots before planting. The crop was harvested in November. Treatments per acre were :—(1) berseem green manure, (2) standard manure, (3) ten tons farmyard manure, (4) twenty tons farmyard manure, and (5) complete minerals. Treatment No. 4 gave the best results which were found to be better than those with treatment No. 1. It may be mentioned that similar results were also obtained last year.

It is generally believed that a close cane rotation such as cane-fallow-cane usually tends to exhaust the land. An experiment designed to maintain the land in the best possible condition for such a type of rotation was started after the harvest of cane in February 1932. The experiment was performed on similar lines to those described in the previous review. The results for the year 1935-36 are in complete agreement with those obtained last year.

Research work on Sugarcane in the UNITED PROVINCES is mainly in progress at Shahjahanpur and at the two sub-stations at Muzaffarnagar and Gorakhpur. The three stations are typical representatives of the chief cane-growing tracts in the United Provinces namely the central, western and eastern tracts. Besides these, most of the Government experimental farms in the province conduct yield tests of the varieties recommended for propagation in respective localities by the Central Research Station at Shahjahanpur.

(*a*) *Selection of new varieties and their relative performance.* In 1935-36 only seven varieties were received from Coimbatore as compared to thirty-six in 1934-35. From the thirty-six varieties two early (Co 428 and Co 508) and four medium and late varieties (Co 421, Co K 10, Co 431 and Co 514) were selected in 1935-36 for final yield tests to be carried out in 1936-37. From the final trial of thirteen varieties in 1935-36, Co 378 (early), Co 393 and Co 411 (medium) warranted distribution to the Government experimental farms in the Province. In order to extend the crushing period of

sugar factories it is the policy to produce and bring into extensive cultivation some very early-maturing varieties, varieties medium in maturity and some very late ripeners.

(*b*) *Manurial and cultural requirements of cane.*

1. *Complete nutrient experiment.* Three doses of N (0 lb., 100 lbs., and 200 lbs. per acre), three of $P_2 O_5$ (0, 75 and 150 lbs. per acre) and three of K (0, 75, and 150 lbs. per acre) were given in all combinations. After analysis the results indicated :—

(i) The returns become uneconomic after 100 lbs. of N at the existing prices of nitrogen and cane.

(ii) There is no effect of $P_2 O_5$ or K on yield.

(iii) The quality of juice deteriorates with the increase of N if only this element is given.

(iv) There is no effect of either $P_2 O_5$ or K on the quality where N remains at 100 lbs. or below. $P_2 O_5$ and K improve the quality of juice at 200 lbs. of N which clearly shows the effect of $P_2 O_5$ and K only at higher doses of N.

2. *Effect of green manure in combination with other manures.* Efficiency of green manure alone and in combination with castor-cake, ammonium sulphate, and cow-dung was tested. The combined effect proved to be superior to green manure alone, but significance between various combinations was negligible.

3. *Molasses as manure.* Three quantities of molasses, namely, 90, 180 and 270 maunds to an acre, were applied alone and in combination with castor-cake, or ammonium sulphate, each applied two months before planting at 60 lbs. N per acre basis. 270 maunds of molasses gave the best yield, the two combinations with ammonium sulphate and castor-cake were equal in themselves but superior to molasses alone.

4. *Water requirement and its relation to N.* Four different numbers of irrigation (3, 4, 5, and 6 irrigations) were combined with three doses of N (60, 100 and 200 lbs.). One irrigation equals 80,000 gallons per acre. The two factors produced an independent effect with no interaction. Progressive increase in yield was noticed with

increased number of irrigations up to six irrigations and profitable limit of N was reached at 100 lbs. The quality of juice deteriorates with increase of N, other elements not being added, but the number of irrigations has no effect on juice quality.

5. *Spacing and fertility of soil.* Three spacings ($1\frac{1}{2}'$, $2\frac{1}{2}'$, $3\frac{1}{2}'$) were given between rows and four grades of N fertility (0, 50, 100, and 200 lbs. per acre) were applied. The limit of profitable application of manure is reached at 100 lbs. of N at existing price of nitrogen and cane and there seems no effect of spacing on yield. There is an interaction between spacing and fertility; the richer the soil, the broader should be the spacing and *vice versâ*. The quality of juice deteriorates with increase of nitrogen (by itself), but there is no effect of spacing on quality of juice.

6. *Methods of planting.* Planting in trenches was compared with that on flat followed by earthing up of the cane and no earthing, with different distances (3′, $3\frac{1}{2}'$, and 4′). Neither the method of planting nor earthing appear to have any effect on yield, while with the increase in distance there was an increase in yield. The quality of juice seemed to deteriorate both in trenches and with earthing, while distance does not affect the juice.

7. *Interculture of sugarcane.* Different depths (surface 1″, shallow $2\frac{1}{2}''$ and deep 4″) of hoeing were combined with different number of hoeings (1, 2, and 3) after each irrigation. Hoeing was found to be very necessary for obtaining good yield. Depth of hoeing being more important than the number; two deep hoeings after each irrigation gave the best results. Quality of juice is not affected either by the depth or number of hoeings.

8. *Time of planting and portion of cane used as seed.* Four dates of planting (in January, February, March and April) were combined with three types of seed (from top portion of cane only, whole cane used as seed and the lower portion only). Yield decreased with later planting, the best time being from the end of January to the end of February. Up till March, it did not matter what portion of cane was planted, but in the April planting, top portion gave the best yield. The general trend is one of lower sucrose with late

planting but the results are not significant. There is, however no effect of seed on quality of juice.

The following experiments were conducted during 1935-36 at the sub-station at Muzaffarnagar :—

(1) *Different combinations of manure.* Farmyard manure, *neem* cake and ammonium sulphate were applied simply and in various combinations at a total N basis of 120 lbs. per acre. The results indicate that the inorganic manures can be best utilized in combinations with the organic manures. Well-balanced manures give a better purity of juice.

(2) *Relative efficiency of molasses, farmyard manure, and neem cake as manures.* The three manures were applied at uniform N basis applied two months before planting, *i.e.*, 47 lbs. N per acre. *Neem* cake and molasses proved superior to farmyard manure and the control. It seems, however, doubtful if the use of molasses will be economical in localities far away from sugar factories on account of heavy expenditure on cartage. Under favourable conditions molasses can be profitably used as manure.

(3) *Manure and varieties.* Differential response of varieties (Co 244, Co 300 and Co 312) to varying quantities of N (0, 60, 120, and 180 lbs. per acre) was tested. Co 312 is the best all-round variety, Co 244 and Co 300 follow in order of merit. Definite interaction exists between the varieties and N quantities. Response to N beyond 60 lbs. per acre is not appreciable. Varieties have a pronounced effect on purity of juice ; Co 300 having the highest purity. Juice purity is also effected though not quite as appreciably as with the varieties, by increasing N quantity ; no manure being better than the plots supplied with N.

(4) *Yield tests of different varieties.*—(i) Early varieties—Seven new varieties were compared with the standard on a well-designed layout of field plots. In yield, Co 312 proved the best of all. Co 385, though inferior to Co 312 in yield, is the earliest of the group and is fit for crushing in the middle of October. Co 370 is a slightly better yielder but not quite so early. Co 313 has good yield but is more susceptible to mosaic. Co 350 equals Co 385 in yield but is not quite so early and drought-resistant as Co 385. (ii) Medium and

late varieties—Eight varieties were put under trial. Co 312 again showed its superiority over others, Co 331 was significantly superior to all except Co 312. Under normal conditions of fertility, Co 331 does not seem to be superior to Co 312, but it is expected that Co 331 might prove its worth better under high fertility and water-logged conditions.

The following tests were also carried out in the Government Agricultural Farm at Gorakhpur :—

(1) *Relative efficiency of different manures.* Castor, *mahua* and *neem* cakes were applied at uniform N basis and at uniform price basis. When each was used supplying 74 lbs. N per acre, castor-cake gave the best results. Whereas when the three were applied at uniform price basis (Rs. 20 worth of each manure per acre) *mahua*-cake proved most profitable, followed by castor-cake and *neem*-cake in order of merit.

(2) *Effect of molasses and castor-cake on ratoon sugarcane.* The two manures were applied singly. Castor-cake proved superior to molasses and molasses gave a significantly higher yield over the control.

(3) *Yield tests of varieties.* The experiment was conducted on ten varieties under different conditions of fertility—medium and rich. Under medium fertility, Co 393 gave the highest yield, Co 331 and Co 395 followed in the order of merit. Co 312 proved a failure, with the lowest yield. On rich soil, however, Co 395 was the heaviest in yield ; the sequence of merit of other varieties was in the order of Co S 5, Co 356, Co 331. Co 312 was again a failure; thus the cane does not seem to be suitable at least for Gorakhpur conditions.

Over and above the experiments on sugarcane in the United Provinces mentioned above, chemical, physiological and entomological studies on sugarcane were also carried out.

The entomological investigations on the sugarcane crop are in progress with the help of financial grants made by the Imperial Council of Agricultural Research. The work is being conducted at the Sugarcane Research Station, Muzaffarnagar. Detailed studies on the sugarcane insect pests chiefly on the cane-borers, leaf-hoppers,

white-fly, white ants, are being made. Their life-histories, incidence of attack and effect upon various canes grown under different cultural treatments and control measures either by parasites or by mechanical and chemical methods are being worked out. Observations are also being made on the nature, life-histories and economical value of their natural parasites.

BIHAR AND ORISSA. (*a*) *Varietal position.* The varietal position remained more or less the same, namely, that the indigenous canes are now rare in Bihar and the new varieties Co 299, Co 313 and Co 331 are slowly getting into the agricultural system of the tract as early, medium-early and late types respectively. Both Co 210 and Co 213 retain their position as mid-season varieties. Of the recent Coimbatore seedlings Co 508 in the early class; Co 371, Co 373, and Co 514 in the medium-early class; and Co 421 and Co 513 in the mid-season class, are outstanding.

(*b*) *Investigation work.* (i) Agronomical—The results of spacing trials with mid-season varieties indicate that three-feet spacing is significantly better than four-feet spacing. Individual row yields, however, are positively higher with wider spacing due mainly to greater number of stalks present. Although differences in juice quality were all along in favour of wider spacing, they were statistically not significant.

(ii) In the trenching trial (trenches $12'' \times 12'' \times 12''$ dug up in November and cane planted early in February) the results were significantly in favour of flat planting. The other points observed were that the germination in trenches was restricted due possibly to defective moisture conditions. The trenches offered a distinct advantage to cane during the hot months. The earthing up of trenches in June gave a serious setback to the crop. The vegetative growth in the trenches was prolonged, maturity being delayed by over a month.

(iii) Manurial experiments confirmed that a combination of 40 lbs. N and 50 lbs. $P_2 O_5$ was the most economical application in North Bihar.

(iv) Hot weather irrigation of cane resulted in higher cane and sugar yields. The growth records showed that irrigations given

during this period provided the plant with an equipment of foliage and surface roots that proved serviceable immediately on the advent of rains, thus ensuring quick response and faster growth. Where cane received no irrigation during the hot weather, it reached the rainy weather poorly provided with requisite foliage and lateral roots so that its phase of quick growth was delayed—a feature of considerable importance in these parts where the main growth season is generally restricted to rainy weather. Study of lateral distribution of irrigation water with a view to deciding upon the number of border rows to be provided in irrigation experiments showed that it extended up to about 54″ on the free side of the last planted row on the light high lands, suggesting a border of 2-3 rows on either side.

(v) Further experiments on seed question in early varieties while confirming the last year's conclusions, namely, that the standing crop was better as seed material than the trashed or pitted one and that it should be planted as soon after January as possible, brought out the better keeping qualities of Co 371, which is reported to be due largely to the protection afforded by leathery scales and general solid texture of the stalk.

(vi) The practice of topping of cane before harvest during December showed negligible losses for first four days, recording actual increase in sugar per cent on the first two days, while the losses were markedly pronounced after the first two days during the month of February. Unless, therefore, the topped cane could be sent to the mill within two days, topping should not be resorted to after the end of January in North Bihar.

(c) *Botanical and physiological.* (i) Germination—The work under this head was confined to the (1) study of causes of poor germination in Co 343, an otherwise promising mid-season cane, and (2) effect of castor-cake application in soils of different moisture content; of direct contact of the setts with artificial manures sprinkled in furrow and of coal-tarring the setts before planting. The poor germination of Co 343 was partly traced to its extremely low capacity for absorption below a certain range of soil moisture content and peculiar lag between the growth of shoot and roots.

Application of castor-cake to light soil below a moisture content of fifteen per cent was found distinctly detrimental to quick and full germination. Where, however, castor-cake was applied after being soaked in water over night, no harmful effects were noticed. The direct contact of setts with the artificials in the furrows affected the viability of the eyes. Coal-tarring the setts under the conditions obtained at Musheri was found to bestow no protection against white ants, while it adversely affected the germination.

(ii) Growth—Periodic records of height measurements and accumulation of dry matter showed differential response to weather conditions by different varieties. In July rainfall was deficient and as a result some of the varieties under trial suffered a serious check in growth which in spite of the adequate rains in August and September was reflected in the harvest results. A high correlation between the stage of growth and the effects of the visitation of an unfavourable circumstance was indicated.

Over and above experiments described above, important data were also collected on root studies, water-requirements and uses of hand refractometer for evaluating cane varieties from sugar point of view and for studying the march of ripening through their life-cycle as well as for developing a suitable sampling technique for experimental purposes.

PUNJAB. As an outcome of the scheme financed jointly by the Imperial Council of Agricultural Research and the Punjab Government, work of great scientific and economic importance has been turned out at the two sugarcane stations, Jullundur and Risalewala, since 1934. The average yield of seven acres of cane works out to be 89·5 maunds (3·3 tons) of *gur* per acre, while the highest yield at Risalewala from an experimental plot 1/40th acre was 149 maunds (5·5 tons). There is thus a good scope for the improvement of low yields in the Punjab by the judicious blending of varieties and cultural operations.

(*a*) *Cultural trials.* (i) The crop sown in lines two feet apart on flat and in trenches and then ridged before rains compares very favourably with that sown on flat, one foot apart (ordinary sowing). The acre-yields of cane were 1036·4 maunds (38·1 tons), 1035·2

maunds (38·0 tons), and 1009·8 maunds (37·1 tons) respectively. The chief advantage in favour of line-sown crop is that all post-sowing operations can be done by bullock-labour. Further the crop thus sown escaped lodging a good deal even on rich soils.

(ii) Results also show that in the Punjab distances over two ft. in between the rows are not economical even for a variety like Co 213.

(iii) On very poor soils closer planting has given better results than wider planting.

(iv) September-sown crop gave sixteen per cent more yield than March-sown crop with Co 285.

(v) Trials regarding the seed-rate and sowings on different dates are still in progress and some important data have been collected.

(*b*) *Manurial experiments.* (i) To determine an economic substitute for farmyard manure and also the optimum dose of nitrogen for cane, the various combinations of *toria* cake and ammonium sulphate applied separately at 35 lbs., 70 lbs. and 105 lbs., N per acre with 70 lbs. N in farmyard manure were tried amongst themselves and against 140 lbs. N in farmyard manure alone, taken as standard. The yields as well as economic returns are in favour of *toria* cake doses compared to their equivalent doses applied in ammonium sulphate. The standard manure, *viz.*, 140 lbs. N per acre in farmyard manure, was the poorest of the lot.

(ii) Results obtained from the trial of nitrogenous (100 lbs. N), phosphatic (75 lbs. P_2O_5), potassic (100, 150 and 200 lbs. K_2O) and complete artificials (100 lbs. N+75 lbs. P_2O_5+150 lbs. K_2O) manures with eight tons of farmyard manure as basic dose in all cases have indicated that the Punjab soils do not respond to potassic and phosphatic manures even when the former was applied at 200 lbs. K_2O per acre. Yields were statistically in favour of nitrogenous and complete manures and the increase in the latter case is attributed mainly to the presence of nitrogen as one of the constituents.

(*c*) *Varietal trials.* (i) Some 150 varieties were under observation. For yield trials varieties were grouped as early, mid-season and late-maturing canes and tried separately. The results show that Co 312 and Co 313, which have recently been released for general

cultivation, are superior to Co 213 and Co 223. Co 312 has also given better yields than Co 285, the standard cane of the Punjab, under different number of irrigations. It, however, lodges on rich soils. Co 331, Co 371, Co 385, Co 392, Co 395 and Co 421 have shown very good growth performances. With regard to drought and frost-resistance and high tonnage Co 421 was an outstanding cane on the farm. Co 385 is a very early cane and maintains its purity till late in the season.

(ii) Under both liberal and restricted waterings, *viz.*, irrigations after 10-12 and 15-10 days respectively, Co 285, Co 312 and Co 313 gave better yields than Co 213 and Co 223. The last two varieties have been found to be very susceptible to drought and their cultivation particularly in localities with ordinary means of irrigation and meagre rainfall is an economic loss to the grower.

(*d*) *Root and seed studies.* (i) As a result of extensive work in this line it has been found out that the thickness of the main and other roots and rootlets, the number and length of secondary and other tertiary roots play an equally important part as the deep root-system does in making the variety drought and frost-resistant.

(ii) Preservation of seed material from frost injury, thick stand of the crop and liberal irrigations before and during frost enable the variety to resist the frost better.

(iii) As regards sucrose formation in the heavily-manured crop under different number of waterings, it was found that in Co 285 there was an increase of 1·5 and 2·75 maunds of sucrose per 100 maunds of cane in favour of waterings applied after seven days as compared to fourteen and twenty-one days respectively. Similar results were obtained with Co 313.

(iv) A point of vital importance has been discovered that seedlings even when 1½ month's old could be successfully transplanted direct into the main field provided this is done before the advent of hot weather. The mortality was not more than 10-15 per cent and the seedlings thus transplanted are now growing vigorously.

With the fall in the price of paddy in the MADRAS presidency extension of cane cultivation is becoming increasingly important. The area under sugarcane is slowly increasing especially in the

vicinity of sugar factories with the result that the demand this year for setts of improved varieties was very great. Aided by the grant given by the Imperial Council of Agricultural Research, an agricultural station was opened at Gudiyattam in February 1935. The fields having been laid out into suitable plots, varietal studies in regard to their germination, root development, growth habit of flowering and ratooning were begun. At Anakapalle there were ninety-seven varieties under trial. In regard to habit, it was found that there is no variety to beat Co 213, while Co 313, otherwise a very promising cane, is disappointing in this character. Taking all aspects of study of these varieties into consideration, Co 313, Co 419, Co 421, Co 602, Co 381 and P O J 2878 are promising. At Samalkotta forty-seven varieties were under study. In the thick cane trials, Co 419 and Co 421 gave an increase of sixty-eight per cent and twenty per cent respectively over J 247. J 247 and Purple Mauritius continued to be popular in the First circle. Co 213, though successful in the uplands and in the lighter type of soils, does not seem to yield to the same appreciable extent as Purple Mauritius in the heavy soils of Godavari delta. The results of the manurial trials at Palur confirmed the findings of the previous year that 200 lbs. of nitrogen as cake and ammonium sulphate gave the highest tonnage.

In the ratooning experiment at Anakapalle, Co 243 and Co 281 gave good yields on wet lands, whereas M A 221 and J 247 fared badly, and at Samalkotta these trials indicated that thin canes are better suited for ratooning than thick canes. Of the seven varieties which were given only a single irrigation during their growth at Samalkotta, Co 210, Co 419 and P O J 2878 withstood summer better than the rest. An irrigation experiment at Palur showed that Co 213 resisted drought best and that Co 285 and Co 243 were also promising, whereas P O J 2878 did not behave satisfactorily under these conditions. Trench planted plots at Palur did not thrive so well as those in beds.

Improved methods of sugarcane cultivation include line-planting, trenching and wide spacing. These improved methods have been adopted throughout the presidency over an area of 36,103 acres

during the year under review. In order to make ryots grow their own seed material, they were encouraged to propagate seed by the 'short crop' method *i.e.*, using a young crop of cane for seed in their own lands.

The total area under sugarcane for 1935-36 in BENGAL was 325,400 acres as against 276,200 acres during the last year. Out of this area 244,326 acres were under Co 213 variety. Co 213 is growing at present in high, low and inundated lands and can stand water for two to three months to a height of 1′ to 2′ without much deterioration in quality. Four new varieties of cane (three early, Co 214, Co 281, and Co 381 and one late Co 331) have been sent out to the district farms for further trial as these have been found to be successful at the Dacca farm.

In order to find out the relative degree of accuracy in the various methods of sampling, samples have been collected at the time of general harvest of the varieties of cane at random of one clump, three clumps, six clumps and field sample, and it has been found that one-clump basis is far from accurate. As regards others, no definite conclusions have yet been arrived at.

The manufacture of sugar by open-pan process conducted by the Agricultural Engineer, Bengal, in his latest K B type furnace is reported to have shown promising results.

The work at the Sugarcane Station at Pyinmana, BURMA consisted of replacement of low tonnage cane varieties with moderate sucrose content formerly in general use, with the Java P O J 2878 and to a lesser extent P O J 2727. A large number of introduced varieties were studied with the object of prolonging the manufacturing season by securing early and late-maturing varieties; experimental work in planting methods and further experiments in the use of fertilizers and methods of manuring this crop were also carried on. Of the introduced canes, Co 360 proved a good cropping cane and while unequal to Java varieties is somewhat earlier in maturing. With the establishment of a second white sugar factory in the previous year in the East Central Circle, Burma, the spread of Java cane P O J 2878 was greatly stimulated. Yield trials with sugarcane were conducted in the Tenasserim Circle, Burma, the results of which

showed that P O J canes were superior on an average by three tons at Magyikyun and eight to ten tons at Bilin to local Toungoo Yellow. P O J 2878 appeared to be a heavier yielder by about four tons over P O J 2727. The results at Magyikyun indicated that canes can successfully be produced on *kaing* (riverine soil subject to inundation) areas. In the same circle ratooning trials were carried on with P O J 2878 and the condition of the standing crops suggested that it will ratoon longer and better than the local canes which used to give one ratoon successfully.

The chief point in the improvement of cultivation is the substitution of furrow planting with subsequent weeding, ridging up and draining for the method of planting on the flat with no subsequent attention. In the investigation of variation of the standard planting methods, it was found that by decreasing the distance between rows from 4½ to 4 feet with the standard P O J 2878, a crop increase of 2·38 per cent was obtained. Similarly by reducing the planting interval in the rows from the standard eighteen inches to fourteen inches the increase was one per cent.

In the manurial trials in the Tenasserim circle, one randomised lime experiment at the rate of 800 lbs. per acre reported last year has now yielded results. Limed plot yielded 11·5 tons canes per acre as against 10·9 tons of the control. This records an increase of 5·5 per cent. The experiment passed the five per cent z test only and as the increase per cent is less than three times the standard error 2·09 per cent, the results cannot be accepted as significant. In the fertilizer experiments in the East Central Circle, a fifth year experiment with nitrogen, potash and phosphate confirmed the apparent absence of any effect from the last two. This was further confirmed by a similar experiment laid out on the estate of the factory at Zeyawadi which gave results in close accord with those at Pyinmana. In the heavy application of sulphate of ammonia, dressings at 60, 80, 100, 120 pounds of nitrogen per acre for the first time gave graduated increase of crop yields up to the maximum amount in which case the increase was sixty-four per cent.

ASSAM. (*a*) *Varietal experiments*—The new varieties, namely, Co 364, Co 408, Co 411 and Co 413, gave an outturn of a little

more than forty tons of stripped cane per acre, whilst Co 419 gave an outturn of fifty-four tons stripped cane per acre, the highest outturn ever recorded in the Jorhat farm. In the preliminary varietal experiments with ratoon canes conducted with six varieties (Co's 358, 402, 407, 408, 410 and 413) with three replications each, it was found that the average outturn and sucrose per acre came to 24·1 tons and 2·59 tons respectively. Co 407 gave the highest outturn followed in order by Co 410, Co 408 and Co 413. All these four varieties behaved satisfactorily, as they did in the plant canes. The varieties Co 358 and Co 402 appeared to be poor both in ratoon as well as in the plant canes. In the experiment with plant canes conducted with four varieties (P O J 2714, P O J 2878, Co 361 and Co 290) with seven replications each, it was observed that the average outturns of stripped cane and sucrose per acre came to 28·03 tons and 3·37 tons respectively which were satisfactory. P O J 2714 gave the highest outturn of cane and total sucrose followed by Co 290 ; P O J 2878 and Co 361 behaved similarly but both of these were inferior to P O J 2714 and Co 290. In the preliminary varietal experiments with *jowar* (*Andropogon Sorghum*) crosses (Co's 351, 353, 355, 356 and 357) and Co 313 replicated three times, it was found that the average outturn of stripped cane and sucrose per acre with the *jowar* crosses, excluding Co 313, came to 22·21 tons and 2·42 tons respectively, which were not quite satisfactory. Considering, however, their early ripening qualities, they appear to be hopeful. Preliminary experiments, with the varieties Co 358, Co 364, Co 402, Co 407, Co 408 and Co 410 to Co 413, with three replications each showed that the average outturn of stripped cane and sucrose per acre came to 38·8 tons and 3·61 tons respectively which were highly satisfactory. The canes were not quite mature at the time of harvest and with late harvest the percentage of sucrose in juice would have increased further. The variety Co 408 was found to have maintained its previous superiority along with Co 413 and Co 407. The new varieties Co 412, Co 411 and Co 364 appeared to be very hopeful. The variety Co 410 was a little poorer than usual, but it has been found to have ratooned quite well this year.

The varieties Co 358 and Co 402 appeared to be much better this year. Similar experiments were also performed with varieties Co 416, Co 417 and Co 419 which gave 41·58 and 3·98 tons as the average outturn of stripped cane and sucrose per acre respectively. The variety Co 419 behaved the best as already stated. The other varieties, although significantly inferior to Co 419, appeared to be hopeful.

(*b*) *Manurial experiments.* The results of manurial experiments on ratoon canes indicated that a mixture of 200 maunds cow-dung and 2,000 lbs. oil-cake per acre is more efficient than either cow-dung or oil-cake applied alone. Besides, the necessity of manuring the ratoon canes is very clearly shown. More detailed experiments are, however, called for. In each of the three experiments in this connection it was found that the quality of juice was better with non-manured plots than with the manured ones which appeared to be an important factor. In the manurial experiments with three varieties (P O J 2714, Co 213 and Teli) and three manurial treatments (no manure, 125 maunds and 250 maunds cow-dung per acre) replicated three times for each combination, it was found that, even with the maximum dose of manuring equivalent to 100 lbs. nitrogen per acre, the varieties behaved much below par than their normal behaviour. Both with regard to yield and their total sucrose, the varieties P O J 2714 and Co 213 were equal and significantly superior to Teli. Regarding manuring, the differences in yield of cane and total sucrose were significant between no manure and 125 maunds cow-dung per acre as well as between the latter and 250 maunds cow-dung per acre. In the manurial experiment with Co 290 with three manures (250 maunds cow-dung, 2,000 lbs. oil-cake and 125 maunds cow-dung *plus* 1,000 lbs. oil-cake) at three different times, it was observed that the results roughly indicated that a mixture of cow-dung and oil-cake is better than the two applied alone, but the differences were not significant. Regarding time of application, the earliest application seemed to be decisively better than the two latter applications which are similar in effect both with regard to yield of cane and total sucrose. The differences in the percentage of sucrose in juice with the different times of

application were not significant. The experiment was conducted with P O J 2714 with different quantities of slaked lime at the rate of *nil*, 10 maunds, 20 maunds, 30 maunds and 40 maunds per acre. Each treatment was replicated six times. The results showed that with the heaviest application of forty maunds slaked lime per acre there was significant increase over no application of lime. The application of ten maunds lime had not the least effect, whereas only a slight increase was obtained with twenty maunds application. Application of thirty maunds lime per acre gave an increase which was not truly significant especially with regard to yield of total sucrose. The increase of 0·5 tons of sucrose with 40 lbs. application of lime over no lime is just sufficient to meet the cost of the lime used and as such the experiment does not seem to have any immediate economic value. It has, however, academic value for the acid soils of Assam and the residual effect of liming in the ratoon canes will be carefully observed as well as the part it is likely to play in the usual rotation of sugarcane lands.

(*c*) *Cultural experiments.* Experiments were conducted with P O J 2878 and Co 210. They consisted of six treatments being the combinations of these varieties and three spacings (rows 3′, 4′ and 5′ apart) replicated four times for each combination. With regard to the variety P O J 2878, it was significantly superior to Co 210 in every respect, that is, regarding yield of cane, total sucrose and percentage of sucrose and glucose in juice. Regarding spacing, 3′ spacing gave significant increase over 5′ spacing both with regard to yield of cane and total sucrose, but the differences between 3′ and 4′ spacing as well as between 4′ and 5′ spacing were not significant. It seems it would be desirable to give 3′ spacing with a thin variety like Co 210 and 4′ spacing with a thick variety like P O J 2878, but the experiment needs more confirmation.

Work on sugarcane in the BOMBAY Presidency has been concentrated at the Sugarcane Research Station, Padegaon, and during 1935-36 it was divided into the following heads :—

(*a*) Agricultural,

(*b*) Crop Physiology,
(*c*) Soil Physics.

(*a*) *Agricultural.* (i) Varietal, cultural and manurial experiments on sugarcane :—

During the year under review, the promising varieties Co 360, Co 290, Co 419, Co 413 and Co 412 were under trial with Pundia, E K 28, P O J 2878 and H M 320. As regards tonnage yields, Co 419 has given the highest outturn of 56·4 tons per acre, while Co 419, Co 402, Co 413, H M 320, P O J 2878, Co 290 and Co 360, were found to be higher yielders than Pundia and E K 28. Experiments were also carried out with these varieties as regards the yields of *gur* and commercial cane sugar. Out of these varieties under trial, Co 360, Co 402, Co 290, H M 320, P O J 2878, E K 28 and Pundia have been under trial continuously for three years. The results when analysed showed that H M 320, Co 402, Co 290, P O J 2878 and Co 360 gave higher yields than Pundia and E K 28, while H M 320 and Co 402 were better yielders than Co 290, which in its turn was found superior in yield to P O J 2878 and Co 360. As regards commercial cane sugar the following varieties have shown results in order of merit—P O J 2878, Co 290, Co 360, H M 320, E K 28, Co 402 and Pundia. Sugarcane-sorghum hybrids were tried at two different times—January and June. Hybrids planted in January showed the same trend of maturity as in the previous year, *i.e.*, none of them matured before tenth month. Hybrids planted in June also did not show maturity till nine months. In point of yield, some of the selections are able to produce thirty-two to thirty-six tons at both the times. In order to secure more period for growth in the flowering varieties, thirteen promising Coimbatore selections with P O J 2878 and E K 28 were planted in October, instead of in January. The indications are that the tonnage could be increased and some of the varieties are ready for cutting from October end. Co 419 and Co 413 have topped the list in tonnage and Co 408, Co 413 and Co 414 topped in early harvest from October end. Nearly eight cane varieties were under trial for suitability in heavy soil. Out

of these, Co 290, Co 413, Co 410, Co 360, Co 407 and Co 408 showed good performance, yielding twenty-eight to thirty-two tons crop per acre within 11½ to 12 months.

In an experiment to test the effect of different quantities of water, 70, 95, 120 and 130 acre-inches of water was applied to two varieties of cane—Pundia and P O J 2878. The quantities were distributed throughout twelve months with a ten day turn. The dose of manuring was uniform, green manuring with sann before cane and 150 lbs. N as a top-dressing applied three times during the plant growth. The three years' results showed that in Pundia, treatment with 95 acre-inches was significantly better than 120 acre-inches which was in its turn better than 130 acre-inches, while the treatment with 70 acre-inches was non-significant. With P O J 2878, treatment with 95 acre-inches was significantly better than 130 acre-inches, while 70 and 120 acre-inches slightly showed higher trend but not significant over 95 acre-inches. Variety Pundia showed a slight increased yield over P O J 2878. The experiment further revealed that (1) the dose of 70 acre-inches has been found to be insufficient during abnormal seasons as it has been traced that the crop goes beyond wilting stage, (2) the dose of 95 acre-inches is the sufficient dose under all seasons for both the varieties with 150 lbs. nitrogenous top-dressing dose and (3) the dose of 130 acre-inches with 150 lbs. nitrogenous top-dressing is deleterious and lowers the yield.

For compost making of cane trash, experiments were conducted with the fresh uncrushed trash using only cow-dung and *gurhal* ash as starter and compactor. Long surface heap system was adopted with 6″ layer of trash sprinkled with cow-dung and ash and thoroughly moistened with water, the maximum height of the heaps being 3½ feet. Rise of temperature was observed within a fortnight. The heaps received in all four turnings, first at the end of the month and the rest after about every three weeks. The experiment was started in June taking advantage of both rainfall and low wind velocity and the compost was ready within five months. A large amount of compost was thus prepared and the

cost per ton works out to be about Rs. 1-5-0, being far below farmyard manure. The analysis of the compost is as follows :—N 0·63 per cent, P_2O_5 0·65 per cent and K_2O 3·35 per cent. The method is greatly simplified and can be conveniently followed by sugarcane growers in the tract.

In an experiment to test the best quantity of nitrogen as top-dressing to cane crop, in addition to the green manure (with sann) before cane, quantities of 75, 100, 150 and 200 lbs. of nitrogen were applied to two cane varieties Pundia and P O J 2878. The results of the experiment showed that 150 lbs. nitrogen top-dressing is not a balanced dose and economical for all seasons in both the varieties even though in a normal season very little difference was shown against the higher dose. The economical differences in the final product with heavier dose were higher in the case of Pundia than in P O J 2878. This has revealed the varietal characteristics as regards bad and good feeding habits of the respective cane varieties. In another experiment to test the best combination of different quantities of farmyard manure and nitrogenous top-dressing to cane-crop, the quantities of farmyard manure 10,000, 20,000 and 30,000 lbs. in combination with 50, 100 and 150 lbs. nitrogenous top-dressing in each case, were applied to two cane varieties Pundia and P O J 2878. The experiment showed that (1) reduction of nitrogenous top-dressing below 150 lbs. is non-economical in any case, (2) reduction of farmyard manure to 10,000 lbs. is also non-economical, (3) in the case of Pundia 30,000 lbs. organic manure showed marked differences over the lower doses, but in P O J 2878, no marked difference was noticeable. This proved, as in other experiments, the good feeding habit of P O J 2878. Experiment was carried on regarding different nitrogenous fertilizers with sann (*Crotalaria juncea*) as basic manure on the cane crop. (1) Sulphate of ammonia, (2) nitrate of soda, (3) nitrate of potash, (4) calcium cynamide—all in combination with cake and (5) sulphate of ammonia—alone—were used to supply nitrogen in the top-dressing. The total quantity of nitrogen used was 150 lbs. in the proportion of fifty per cent from fertilizers and fifty per cent from cake in all four cases except the last where the total was used from sulphate of ammonia alone. This

dose was applied to cane crop (Pundia) in three periods during the plant growth. This year's results showed the same trend as in the past year except sodium treatment which has exceeded sulphate of ammonia (1) in yield but not significantly. The three years' results have proved that (*a*) treatment (1) with sulphate of ammonia has shown high significance over treatment (5) where sulphate of ammonia alone is used as top-dressing, and (*b*) there are no significant differences with the use of nitrate of soda, nitrate of potash, calcium cynamide in comparison with sulphate of ammonia in combination with cake. In an experiment to test the effect of application of superphosphate dose to the usual 150 lbs. nitrogenous top-dressing, 100 lbs. P_2O_5 in the form of superphosphate was applied to Pundia cane before planting in addition to green manuring (with sann). The results this year showed a similar trend to last year, with a higher *gur* to cane ratio, which has proved the utility of superphosphate to these soils.

(*b*) *Crop physiology.*—Bioclimatic, cultural and manurial experiments on sugarcane.

The main experimental programme under this head is reported to be practically the same as last year. Additional experiments were, however, laid out to test the previous findings on (1) germination, (2) periodic distribution of the top-dressing and the interrelation of water to manure. Bioclimatic studies were continued as in the previous two seasons and the data are being accumulated. The comparison of the cane-growth data for the two seasons 1934-35 and 1935-36 showed that the flowering varieties like P O J 2878 are not able to recoup the loss in growth due to adverse meteorological factors during the early grand period stage in spite of favourable climatic conditions later. On the other hand, non-flowering varieties like Pundia are found to correct it to a great extent. In field experiments with measured quantities of water, the periodical moisture figures showed from the stand-point of water requirements that the early grand period stage is the most critical stage in the life of the plant and at this time, the treatment 70″ falls short of the crop requirements. As regards the other treatments, the

fluctuations in the soil moisture either before or after irrigation are found to be similar in all and it seemed, therefore, that the excess irrigational dose in treatments above 95″ is lost by leaching which in 130″ is found to lower the nitrate content resulting in deleterious effect on crop-growth and final yields. No differences were found between 95″ and 120″ treatments. As regards the experiment on relation of water to manure, the findings of the previous season from the periodical determination in the series with varying quantities of irrigation were further tested in both the light and medium soils by small scale field trials with different combinations of water and manure upto 130 acre-inches and 300 lbs. N. The experiments in light soil have confirmed the observations regarding the necessity of higher manuring with higher irrigation. It was further found that the application of the total delta in low doses by short time irrigations gave higher yields than the standard method of ten days' turns. In the medium soil, however, the results are not so conclusive. The favourable effect on germination of the application of sulphate of ammonia at the time of planting was found to be more pronounced than during the previous year in case of adverse conditions of either climate, soil or planting material. Over and above these trials, experiments were also carried on—(1) Rotational crops, (2) Earthing up *versus* non-earthing up and (3) Decomposition of sugarcane trash by direct incorporation in the soil.

Experiments were continued regarding the manurial requirements of cane. Experiments of the last two seasons with doses up to 300 lbs. N. showed higher yields as well as higher intake of the mineral constituents by the crop with increased quantities of top-dressing. It seemed, therefore, that the optimum intake has not been reached and it was proposed to investigate this further by giving still higher doses upto 600 lbs. N. The results corroborated the findings of the previous two seasons as regards increased growth as well higher nitrogen intake with additional doses of top-dressing upto 300 lbs. N. On the other hand, among the treatments above 300 lbs. N. no significant differences either in physiological response, yield as well as intake of nitrogen were observed and it seemed, therefore, that the treatment of 300 lbs. N. would be the optimum

dose for the crop. It was, however, considered, that the unresponsiveness of these higher treatments was due to the application of the top-dressings according to the Manjri method and as this method was found to be defective, it is proposed to run the experiment on an alternative method. Preliminary experiments on the periodic intake during the different stages of plant activities and exudation studies showed that the cane plant is capable of absorbing both nitrates and ammonia. Water-culture experiments have not only confirmed this but have further indicated that it preferred ammonia to nitrates resulting in better growth of the crop.

(*c*) *Soil physics.* Two specific surveys undertaken on the Pravara and Godavari canals in 1934-35 were brought to a close during the year under review. Indications obtained in the more important farm experiments are as follows. Experiments with different duties of water-fluctuations showed that throughout the year the nitrate nitrogen levels were low in the control plots in the light and medium soils as compared with the results of the previous year, and hence further lowering of the nitrate values with irrigation was not so pronounced. On the contrary, there was increase in the nitrate contents in the irrigated plots over the control early in the month of September in all the soils. Experiments with different nitrogenous, potassic and phosphatic fertilizers showed that the available portions of these fertilizers are all released during the first six months after their application and very little can be washed out from the soils after this period. There has been fixation of nitrogen in the farmyard-manure-treated plots, whereas losses of nitrogen have taken place in the case of the rest of the fertilizers. Losses of K_2O from potassic fertilizers have remained constant when compared with the previous results, but the losses of P_2O_5 from the corresponding fertilizers have been greater in most cases showing greater availability of phosphates during the year under report. In addition to the above, the following experiments were also conducted :—

(1) Effect of continuous cropping and the recuperative effects of fallows on soil.

(2) Effect of common *kharif* rotational crops on soil tilth.

(3) Weed burying experiments.
(4) Phosphate availability experiments.
(5) Reclamation experiments in heavy (*chopan*) soil.
(6) Preliminary trial of leguminous weed *patada shevra* (*Alasicarpus belgaumensis*) as a possible manuring crop.

Soil colloid studies and bacteriological work were also continued.

In the NORTH-WEST FRONTIER PROVINCE, a manurial experiment with farmyard manure and silt was conducted. It was assumed that silt in four times the quantity of farmyard manure gives equal results. Treatments were ten cart-loads of farmyard manure per acre and forty cart-loads per acre. The variety on which the experiment was tried was Assam Red with four replications for each treatment. In point of yield as well as economically, silt was found to be better than farmyard manure. Experiments in green manuring consisted of (i) berseen ploughed-in *versus* fallow, (ii) shaftal ploughed-in *versus* fallow, (iii) *arhar* (*Cajanus indicus*) ploughed-in *versus* *arhar*-removed, (iv) sann-hemp ploughed-in *versus* sann-hemp removed and (v) *guara* (*Cyamopsis psoraloides*) ploughed-in *versus* *guara*-removed. Co 285 and Co 290 were used for treatment No. (i), Co 360 and Co 361 for No. (ii), Poundah for No. (iii), Co 400 and Co 412 for No. (iv) and Co 361 and Co 362 for No. (v). Shaftal green manure gave somewhat better results than the rest. The varieties Co 412 and Co 361 were found to be the best of all the varieties tried on the field scale.

As regards cultural trials, the experiment was conducted to compare the cultivation of a bullock hoe with that of a *deshi* (country-made) hoe. Treatments were two, four and eight bullock and *deshi* hoeings respectively with four replications. On the whole, cultivation by *deshi* hoeings was found better than bullock hoeings. The varieties on which the experiment was tried were Co 285 and Co 290. Experiment was conducted on planting in the first week and last week of March respectively, with the variety Poundah with six replications. Planting in the first week of March gave better yields. In the spacing experiment of ridges 3′ and 4′ apart with the variety Poundah and ten replications, it was found that spacing of ridges 3′ apart gave better results.

CENTRAL PROVINCES. (*a*) Varietal and cultural experiments on sugarcane. Amongst the sugarcane varieties, Co 300, a new variety under trial on the Government Farm, Chhindwara, gave a good account by giving an additional yield of 1,010 lbs. over Co 210 which is considered to be the standard variety. A similar test conducted at the Waraseoni Farm indicated that Co 312 and Co 313 were heavy yielders compared to the standard variety. It is reported that these new varieties are likely to replace Co 210 in the near future. There was a good demand for Co 237. E K 28 and P O J, two new varieties of cane, were obtained and propagated for further trial on the farm.

A dry method of planting cane which requires only four to five irrigations during the period of growth was successfully tried at the Government Farm, Bilaspur, and has been given extended trial during 1935-36. It is reported that it reduces the cultivation charges to the minimum and maintains the yield of the irrigated crop.

(*b*) *Miscellaneous.* Experiments with a view to improving keeping quality of *gur* prepared on the Government Farm, Bilaspur, were carried out. Samples of *gur* have been prepared by different methods and their keeping quality will be judged after the rainy season is over and the most promising methods will be tried again in the coming sugarcane crushing season.

5. Jute

THE total estimated area under jute in the four provinces of Bengal, Bihar, Orissa and Assam during 1936 was 2,545,600 acres as against a revised final estimate of 2,180,900 acres of the previous year; this showed an increase of 364,700 acres over last year.

In BENGAL, at the outset rainfall was defective and the progress of sowings was slow. Later on, occasional good showers facilitated sowings in Eastern Bengal. Alternate rainfall and sunshine helped growth and development generally. These favourable weather conditions, combined with the expectation of a fairly good price for the season's crop, account for the increase in acreage which, but for the restriction propaganda, would have been much higher.

As in the previous year, all Government agencies including the officers of the Bengal Agricultural Department were engaged in the restriction campaign and all efforts were made to make it a success. A good number of agricultural demonstrators were appointed temporarily for propaganda work and to advise the cultivators as to substitute crops for jute. The Government of Bengal also sanctioned the free distribution of about 400 mds. of groundnut and a large number of sugarcane cuttings. On the average of the five years ending 1934-35 the area under jute in Bengal was 85·5 per cent, in Bihar and Orissa 7·5 per cent and in Assam 5·9 per cent of the total area under jute in British India. The total estimated outturn of jute for the four provinces during the year was 8,735,800 bales of 400 lbs. each, against 7,239,600 bales (revised) in the previous year.

In BIHAR, the weather conditions were reported to be on the whole favourable in the most important jute district of Purnea and also in other jute districts. Sowings were normal. In ORISSA, light rain fell in the early part of the season, but in May and June heavy rainfall occurred in Cuttack and Balasore and nearly half of the area sown in Balasore was reported to be damaged by rain and floods. In ASSAM, the season was at first favourable for the cultivation and growth of the crop, but a high flood in the latter part of May considerably damaged the crop in both valleys and damage by insect was also reported from Kamrup. The final condition of the crop was, however, satisfactory and a better out-turn than the previous year was the result.

The following are the results of the average yield per acre of some of the promising departmental selected *Capsularis* varieties.

	Md.*	Sr.*	Ch.*
D 386	18	6	6
D 154	17	4	1
R 85	16	24	2
Cross early	15	30	0

* *Maund*=40 seers or 82$\frac{2}{7}$ lbs.; *Seer*=2$\frac{5}{13}$ lbs. *Chittak*=$\frac{1}{16}$ of a seer or 2$\frac{2}{5}$ oz.

Similar varietal trials were conducted with *Olitorius* selected varieties against different local varieties. The following gives the outturn per acre :—

	Average outturn per acre. Md.	Sr.	Ch.
Chinsurah Green (Departmentally recommended).	23	30	3
R 26	21	14	0
Dacca Local	19	39	0
Berhampore Local	20	0	0
Chinsurah Local	20	5	0
Pabna Local	21	24	0
Rajshahi Local	19	13	0

It will be observed that Chinsurah Green, the departmental variety, remains unbeaten.

Samples of jute from varietal experiments in different parts of Bengal for the year 1934-35 were sent to the Secretary, Dundee Chamber of Commerce, for appraisement. The assessors divided the samples into eight classes according to quality. The new selection D 386 was one of the samples which was put in class I. This variety, as may be seen above, has also given the highest outturn of fibre throughout the province during the year, and if this standard is maintained for some years, the departmental D 154 variety will be ousted. D 386 was found to be also as resistant to chlorosis as D 154.

It has been found that for seed production a late-sown crop gives a better outturn than an early-sown one. This is particularly true with the *Olitorius* variety. Cultivators growing the crop for seed production only should grow this after an early catch crop.

In April 1935 the average price of first mark jute was Rs. 6-6 per maund and this rose by the end of May 1935 to Rs. 7-8 per maund. This was maintained till June 1935. During the next three months there was a gradual fall in price, perhaps due to an apprehension that the official estimate might prove to be lower than the actual. By the end of September 1935 the price came down to Rs. 5-12 per maund. From October 1935 the price began to rise and by the beginning of November 1935 the price rose upto Rs. 7-12 per maund. The average price per maund for the season

was Rs. 5-5. In July the price was Rs. 5-6, falling to about Rs. 4-2 in September. Towards the latter end of the season, however, the price rose to about Rs. 6-4.

6. Other Fibres

Hemp. Selection work was in progress at the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, PUSA. The F_2 generation of the cross between yellow and white-flowered varieties of *Hibiscus sabdariffa* L & *H. cannabinus* L. showed a ratio of three yellow-flowered plants to one white-flowered, indicating a simple monofactorial segregation. The F_3 plants, however, did not thrive.

Sann-hemp. (*Crotalaria juncea*). In common with other soft fibres, prices of Indian hemp appreciated during the year in consequence of the withdrawal from the market of supplies of Italian hemp. The exports in 1935-36 amounted to 643,000 cwts. valued at Rs. 60 lakhs, as compared with 437,000 cwts. valued at Rs. 39 lakhs in 1934-35, an increase of 47 per cent in quantity and 54 per cent in value.

At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, PUSA, a number of strains of sann-hemp have been selected for further trials. The study of the root-system was completed. An experiment was laid out during the year with one Pusa and four Bengal varieties of sann-hemp to secure useful information regarding the best varieties, the correct seed-rate and the most suitable time of sowing the crop for fibre purposes.

BIHAR AND ORISSA. Experiments on controlled pollination of sann-hemp flowers were continued. Fully open flowers inside the experimental bags were tripped both by mechanical and biotic agencies. In both cases there was initiation inside the pods of a remarkable setting of viable seeds. Six samples of sann-hemp fibres prepared in the Botanical Experimental Area at Sabour were tested by the Imperial Institute, London, and the report showed that all were of excellent quality. They were all practically similar in composition, quality and commercial value, with possibly a very slight preference in favour of sample No. 1 Sabour A.

Amongst the early varieties of sann-hemp, two kinds of grain colours, namely mouse and Payne's grey, were noticed. A sample from Raneshwar proved to be the earliest variety.

UNITED PROVINCES. The improved sann-hemp strain C 12 maintained its superiority in yield and quality, out-yielding local varieties in replicated trials by over seventeen per cent. It is hoped to accelerate the provision of seed by encouraging its growth in the Meerut tube-well areas.

Sisal hemp. In BENGAL sisal-hemp is being cultivated on District Farms, because of its two-fold benefits, *viz.*, use as a protection or hedge and yield of fibre of economic importance.

Rhea. In BENGAL trials were made with a sample of rhea seed received from the Bureau of Plant Industry, Leningrad. This appears to have the advantage of freely seeding, and its extraction is also somewhat easier than the local variety. This variety will be tried in the Rangpur District as well as at the Dacca Farm.

Flax. BENGAL. For some years past the Assistant Fibre Expert, Bengal, has been conducting experiments on a small scale in the extraction of flax fibre and it has been found that further investigations are necessary on the following matters of detail: (i) the time of harvesting, (ii) storage of straw and (iii) methods of extraction. A small grant has been made to the Bengal Agricultural Department by the Imperial Council of Agricultural Research for experiments on a new method of extracting fibre flax from unretted straw and for the purchase of small hand-power breaking and scutching machines. The work is also of potential interest to the United Provinces and Bihar. In Rangpur and Dinajpur the soil conditions seem to suit the crop.

In connection with the extraction of flax, a simple scutching implement was evolved and its use has been applied to the preparation of sann-hemp. Fibre scutched with this implement received a premium of one rupee per maund over unscutched fibre.

At the BOTANICAL SUB-STATION, KARNAL, a quantity of flax seed was multiplied at the request of the Assistant Fibre Expert, Bengal.

7. Tobacco

THE total area under tobacco in India was 1,357,000 acres in 1935-36 as compared with 1,410,000 acres in 1934-35, and the total yield of dried leaf amounted to 651,000 tons in 1935-36 as against 684,000 tons in 1934-35. The bulk of the tobacco grown is consumed in the country but there is a small though valuable export trade, chiefly of unmanufactured leaf. The exports of unmanufactured leaf rose from 26·3 million lbs. valued at Rs. seventy-eight lakhs in 1934-35, to 28·7 million lbs. valued at Rs. eighty-eight lakhs in the year under review. The most important outlet for Indian tobacco was, as usual, the United Kingdom, which took 11·7 million lbs. during the year as compared with 9·3 million lbs. in 1934-35. Throughout there was a very good demand from the United Kingdom for bright Virginia leaf suitable for cigarette manufacture. The total imports of both manufactured and unmanufactured tobacco fell from 3·7 million lbs. valued at 6·18 million rupees in 1934-35, to 2·86 million lbs. valued at 6·16 million rupees in 1935-36. The imports of ready-made cigarettes increased from 614,400 lbs. in 1934-35 to 831,000 lbs. in 1935-36, the total value of the imports being rupees twenty-eight lakhs in 1935-36 as compared with rupees twenty-two lakhs in the preceding year. The imports from the United Kingdom accounted for nearly rupees twenty-seven lakhs. The imports of unmanufactured tobacco decreased from three million lbs. in 1934-35 to 1·9 million lbs. in the year under review, the imports being principally from the U. S. A.

Though India holds a high position among tobacco-growing countries, she does not take a proportionate share of the international trade in this commodity, the reason for this being that almost all the tobaccos hitherto grown in India yield a dark coarse leaf which gives a strong and pungent smoke unsuitable for cigarettes but suitable for use in the *bidi* (indigenous cigarettes), the *hooka* (water-pipe) or as snuff. The problem of tobacco improvement in India therefore means the production of a good cigarette tobacco which will meet the requirements of cigarette factories in India and replace the present large imports of Virginian leaf and will also be suitable for export.

The improvement of the indigenous tobaccos used for cigars, *bidis, hooka,* chewing and snuff is also of importance.

As regards the production of a cigarette tobacco, a good deal of work has already been carried out at Pusa. Two Pusa hybrids (Nos. 177 and 142) are now available which give a leaf, the colour of which when flue-cured is as good as that of Adcock or Harrison's Special. The importance of flue-curing in the manufacture of cigarette-tobacco having been established and the details of the process having also been worked out at Pusa, the method of flue-curing has now almost entirely supplanted the old rack-curing method. A large number of flue-barns are now being profitably worked in North Bihar, the United Provinces and Madras, and experiments in flue-curing are in progress in the Punjab and Burma.

During the year under report the all-India scheme for the improvement of the quality of cigarette tobacco, which is financed by the Imperial Council of Agricultural Research, came into operation, and a series of co-operative experiments on the growing and flue-curing of Virginian tobacco is now in progress in all the tobacco-growing provinces and some of the Indian States. The experimental work under this co-operative scheme has been arranged as follows :—

The investigations on the chemical changes which take place in the leaf (as a result of curing, bulking and storage), the control of weevils and the possibility of artificial maturation will be taken up by the Imperial Agricultural Research Institute at the Tobacco Sub-station to be shortly started at Guntur. The Imperial Agricultural Research Institute will also arrange for expert valuations of the leaf grown at the various co-operating centres. Certain experiments on the effect of environment on the chemical composition and quality of Indian-grown cigarette tobacco will also be undertaken by the Imperial Agricultural Research Institute and each co-operating centre will be expected to supply the Imperial Economic Botanist with the necessary tobacco leaf. It will be left to the discretion of each agricultural department to undertake such further provincial studies on the chemical composition of tobacco leaf produced on different soils and under different ecological

conditions as may be necessary. For the co-operative experiments, seeds of standard types will be supplied free by the Imperial Agricultural Research Institute and details of the experimental work at each station will be settled in consultation with that Institute.

Some progress was made during the year with the provincial co-operative experiments. In the Punjab one barn is being erected at the Jullundur Experimental Station where tobacco will be grown under well-irrigation and the other at Lyallpur where tobacco is a canal-irrigated crop. In Bombay one standard barn was erected at the Nadiad Farm and four acres of land are being provided by the Local Government for these experiments. The second barn will be erected at the Borsad Farm or other suitable centre, after the results of the work at Nadiad Farm become available. In Bengal one barn will be erected at the Dacca Farm during the next season and the site for the other barn will be chosen after the results of the present season's crop are known.

The question of the grading and marketing of tobacco has also received attention. The Agricultural Marketing Adviser to the Government of India and his staff have undertaken and nearly completed an all-India survey of tobacco-marketing and the results of this survey, when ready, are expected to give a complete and up-to-date picture of this aspect of the problem.

Work on tobacco improvement was continued in the Imperial Agricultural Research Institute during the year and a cross between *N. tabacum* and *N. plumbaginifolia* was under study. The hybrids were completely sterile and showed a number of features, *e.g.*, striping and streaking of flowers not found in either of the plants. This is the first time that plants from this difficult cross have been successfully raised to maturity. The study of the 'leaf-curl' disease was continued by the Imperial Economic Botanist in collaboration with the Imperial Entomologist. Five types of leaf-curl have been provisionally distinguished and experiments on these are in progress. The incidence of this group of diseases was also studied and weekly counts of diseased plants were taken from the time of transplanting up to harvest. The data indicate that a certain amount of new infection takes place

throughout the season but it is highest just after the seedlings are planted out.

In MADRAS the most important tobacco-growing centre is in Guntur district, where about 120,000 acres are annually under this crop. The centres next in importance are in the Vizagapatam, Coimbatore, East Godavari and Madura districts. Cigarette tobacco of the Virginian type is reported to be spreading in the Kistna district where about 3,000 acres are under this type. A departmental strain known as H S 9 fetched a premium of Rs. 10 per candy (500 lbs.) over the local and was popular with the ryots.

Work on the improvement of the local crop was continued at the Agricultural Research Station, Guntur. Out of the four strains of cigarette tobacco under trial, a strain called H S 8 gave an increased yield of 2·3 per cent over the local Harrison's Special and was also superior in quality. Other work in progress at the station included trials with selected strains of Virginian tobacco, a study of the inheritance of characters in six different crosses between indigenous and exotic types and efforts to acclimatise a *bidi* tobacco from the Ceded Districts and a *hooka* tobacco from Pusa. The 'Black Shank' disease of tobacco was studied and it was found that sterilization of seed-bed by burning trash, disinfection of seed by silver nitrate and spraying of the nursery plants with Bordeaux mixture were effective in controlling it.

In BOMBAY there are two main tobacco-growing regions, (*a*) the area in the Western Deccan and the Southern Maratha country, centreing round Kohlapur but extending into the Belgaum district on the south and to a less extent into the Satara district on the north, and (*b*) the area in Northern Gujarat where the cultivation centres round Nadiad in the Kaira District.

Tobacco improvement work was continued at the Tobacco Research Station, Nadiad, where work is in progress on the selection of a variety suitable for cigarette manufacture and for local use from the crosses between the best local selections (G 6 and P 28) and the Virginian varieties. Experiments on the best method of raising seedlings showed the advantages of a seed-rate of $\frac{1}{4}$ tola per bed of $4' \times 4'$ and an application of ammonium sulphate to the

seed-beds. A study of the comparative cost of production of Harrison's Special flue-cured tobacco *v.* G 6 (as cigarette tobacco) showed a gain of Rs. 42 for the former after deducting the curing expenses. Experiments on the technique of flue-curing were continued and an improved method was devised by which the yellowing stage could be secured within a shorter time than usual.

In Bengal the main tobacco-growing areas are in the districts of Jalpaiguri and Rangpur and in the State of Cooch Bihar. The departmental selections from the local types Motihari, Bhengi and Biri, are reported to be in great demand and about 4,911 tolas of seed were distributed during the year. Of 307,000 acres under tobacco in the province, 70,000 acres are reported to be under these types.

Trials with a number of foreign and indigenous varieties were continued at Dacca and Rangpur. Of the tobaccos of the Virginian group, White Burley maintained its popularity. Under the all-India scheme for the improvement of cigarette tobacco, three cigarette types, Harrison's Special, Adcock and Pusa hybrid 142, were given a systematic trial in a number of places in the province. On the light soils of North Bengal, these varieties yielded a good quality tobacco. Manurial experiments showed that mustard cake helps the formation of thicker leaves and thus increases the yield eventually. Efforts towards the creation of a foreign market for the flue-cured Ohio variety were continued. A sample of the cured leaf sent to the Indian Trade Commissioner, London, elicited the opinion that the leaf, though short, was of good quality, the prices assessed being however on the low side. A further consignment will be sent after the present year's crop has matured.

At the instance of the Collector, Rangpur, classes in cigar-making were opened at two centres during the year. The cheroots manufactured at Dacca are reported to be increasing in popularity and the sales increased from Rs. 702 to Rs. 1,268.

The United Provinces form an important tobacco-growing area, with 84,000 acres under this crop in 1935-36. The chief tobacco-growing districts are: Farrukabad, Sitapur, Jaunpur, Budaun, Mainpuri, Etah, Aligarh and Meerut. Nearly 80-90 per cent of

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the indigenous tobacco grown in these provinces is the *N. rustica* type and the remaining 10-20 per cent is of *N. tabacum*. The cultivation of cigarette tobacco is still in its infancy, the estimated area being about one-hundred acres. With the introduction of the new flue-curing process, the light soil of a considerable area of the Saharanpur district seems capable of producing a high quality of Virginian cigarette leaf which is likely to command a good market. Further experimental work is required.

In the PUNJAB tobacco is grown in all the districts, except Simla and Rawalpindi. Ninety-eight per cent of the total area under the crop is grown under irrigation, with the result that the crop is of considerable importance in districts where irrigation facilities are adequate. The economic value of the crop to the province has been estimated to be over Rs. sixty-six lakhs per annum. The Department has a number of indigenous and foreign varieties under trial. Among *hooka* varieties, T 63 gave the highest yield. The promising cigarette varieties under trial were Hybrid 142, Gold Leaf Virginia, Harrison's Special, Russian, Hybrid 177 and Adcock. Experiments with vernalization in tobacco were started during the year, and the effect of humidity, light and air was studied. The curing of leaf for cigarettes was done both by flue and ordinary rack systems at Jullundur and Lyallpur. The cured leaf was sent to different factories for valuation and on the average was priced at about annas four per lb. A certain amount of Virginia tobacco is already grown in this province, and it is hoped that with the construction of the flue-curing barns at Lyallpur and Jullundur an industry in cigarette-tobacco will develop.

In BURMA the main tobacco-growing areas are along the big rivers, on land which is subject to submergence under flood water during the monsoon period. The local demand is chiefly for cheroot tobacco. The Departmental work on tobacco is confined to a small area of riverain land at Saaing which is an annexe to the Allanmyo Agricultural Station. A number of exotic varieties are under trial and methods of curing are also being worked out with a viw to improving the Burma cheroot and also to get a type of tobacco

suitable for cigarette-making. During the year under review, small plots of Adcock, Harrison's Special and Hybrid 142 tobacco were grown by the Economic Botanist, but the seedlings were badly damaged by late rains and cut-worms. Plants were bagged to obtain pure seed for the next season.

In BIHAR there are two main blocks of tobacco grown, the most important one being in the Tirhut division and confined mainly to the districts of Muzaffarpur and Darbhanga. The area of second importance is in the Purnea district. There are factories at Dalsingsarai and Monghyr which buy large quantities of the best of the local tobacco for cigarette-making. With the financial help of the Imperial Council of Agricultural Research, two flue-curing barns have been set up at the Agricultural Research Institute, Sabour, near Bhagalpur. Varietal and manurial trials were continued at the Sabour Research Station. Motihari, an indigenous variety, gave the highest yield during the year under report, though Pusa 177 had topped the list in previous years.

In ORISSA, the total area under tobacco is about 14,000 acres of which 10,000 acres are in the Cuttack district. More than 500 acres are reported to be under improved varieties.

In the CENTRAL PROVINCES, a study was made of the 'damping-off' disease in tobacco seedlings caused by the fungus *Phytophthora*. Removal of the diseased seedlings and irrigation of the beds with Bordeaux mixture were found to be effective remedies.

Tobacco cultivation in SIND is carried on in Hyderabad, Sukkur, Nawabshah and Dadu districts, the average annual acreage under this crop being about 7,000. During the year early plantings of tobacco seedlings were successfully experimented with at Sakrand, and it was definitely established that under Sind conditions tobacco seed should be sown in the first fortnight of June and the seedlings should be transplanted on or before the 15th of August. The crop thus grown matures before there is any serious risk of frost damage. In order to hasten the ripening of the leaves, the tobacco crop should not be irrigated after the 20th of October. The main varieties tested during the year were Hybrid 142, Guntur Adcock, Pusa Adcock and Hybrid 177. All these grew well. A top-dressing

of goat-manure during the growth of the crop encouraged the maximum development of the leaf. Harrison's Special was also tried and it developed well and gave a high yield.

In HYDERABAD there are two cigarette factories, leaf for which is mostly imported from the Madras Presidency. Experiments with different varieties of tobacco have been in progress at the Government farms during the past few years. Of the imported varieties, Adcock has given good outturns. Under the all-India scheme for tobacco improvement, work was commenced at the Warangal farm during the year.

In BARODA STATE efforts have been made to cure varieties of American tobacco such as Adcock and other varieties of like type, using the flue-curing barn. Results have been, however, somewhat vitiated by frost in two of the four years of trial. Attempts to safeguard against damage from frost by early planting have not been effective, as the quality of the leaf secured from early planting has been poor. The varieties on these soils appear particularly susceptible to leaf-curl.

A large-scale experiment to test the possibility of producing flue-cured cigarette tobacco at Dhar was carried out by the INSTITUTE OF PLANT INDUSTRY, INDORE, with the financial assistance of the Dhar Darbar. The economic aspect is being examined and the flue-cured products have been sent for expert opinion.

8. Oil-seeds

THE Imperial Council of Agricultural Research continued the grant of Rs. 30,000 to the Oil Technology Section of the Harcourt Butler Technological Institute at Cawnpore. The Institute continued to admit to the Oil Section of the Institute, free of all fees, seven candidates nominated by the Council from other provinces.

The Council continued to issue weekly circulars containing useful information regarding the linseed trade in India and abroad.

In accordance with the suggestions of the Oil-seeds Committee, the Council arranged through the High Commissioner for India for

tests on experimental consignments of soya-beans from the Punjab, in order to ascertain possibilities of a market in London for Indian-grown soya-beans. The results of the examination of Pusa White, Manchurian and Punjab White varieties have shown that these varieties in commercial lots are readily saleable in the United Kingdom and that the Punjab-grown Manchurian White variety might realize slightly higher price as it possesses a higher oil-and protein-content.

The estimated area and yield of the principal oil-seeds in 1935-36, as compared with 1934-35, are presented in the following table.

	1934-35		1935-36	
	Area in thousands of acres	Yield in thousands of tons	Area in thousands of acres	Yield in thousands of tons
Groundnut	5,788	1,896	5,784	2,228
Sesamum	5,222	408	5,633	461
Rape and mustard	5,332	900	5,268	954
Linseed	3,381	418	3,402	384
Castor	1,450	106	1,447	119
Cotton	..	1,741	..	2,062

In 1935-36 the production of cotton was 5,728,000 bales and the output of cotton seed calculated at 0·36 of a ton per bale may be estimated at 2,062,000 tons. In spite of the remarkable increase in the export of groundnut, the exports of oil-seeds have, on the whole, decreased, since the war. The exports of cotton seed and sesamum have ceased and there is considerable fall in the exports of rape and mustard and castor. Since the war, there has been an increase in the area under principal oil-seeds, but the decline in the exports is explained as due to the larger internal consumption of oil-seeds like linseed and cotton seed and the barriers to free trade in the shape of exchange restrictions, quotas and tariffs. The total value of the exports in 1935-36 did not, however, decline appreciably in spite of the large reduction in the quantity shipped. As against Rs. 10,54 lakhs in 1934-35, exports in 1935-36 were

valued at Rs. 10,33 lakhs. The year under review was generally favourable for oil-seeds and vegetable oils. The shortage of edible oils and fats in the United States of America was of much benefit to the export trade. The prices of most kinds of seeds and oils were on a higher level, but the prices of linseed remained low for the greater part of 1935.

Exports of oil-seeds in thousands of tons

—	Pre-war average	1934-35	1935-36
Groundnut	212	511	413
Linseed	379	238	165
Castor	114	69	60
Rape and mustard	277	40	21
Cotton seed	240	1	1
Sesamum	119	1	1
Others	102	3	3
TOTAL	1,443	866	664

The exports of vegetable oils have increased, but the exports of oil-cakes have been on a smaller scale.

Exports of oils and oil-cakes

—	1934-35	1935-36
Vegetable oils, in gallons	2,176,000	2,370,000
Oil-cakes, in tons	348,000	300,000

Groundnut. The area under groundnut increased slightly in 1935-36. The principal areas in which this crop is grown are Madras with 2·5 million acres; Bombay with 0·83 million acres; and the Hyderabad State with 1·05 million acres.

The production of groundnuts in 1935-36 season has been estimated at 2,167,000 tons (in shell) as against 1,883,000 tons in the preceding year. The total declared value of the exports improved from Rs. 593 lakhs in 1934-35 to Rs. 665 lakhs in 1935-36, owing to the high prices which prevailed during the greater part of the year. The price of machine-decorticated groundnuts in Madras market rose from Rs. 37-14 per candy (500 lbs.) in the beginning of April to Rs. 40 in May, but it declined to about Rs. 34 towards the end of March 1936.

MADRAS. The improved strain A H 25, that was for the first time released in 1934-35, is becoming popular in all the districts due to its high yield and to the ease in lifting from the soil. Eleven thousand one hundred and seventy-one pounds of improved seed were distributed during the year. In certain districts, H G 1 has also done well.

Sowing of groundnut in every furrow instead of in alternate furrows was carried out in a larger area. Demonstrations of improved method of lifting groundnut with H M Guntaka 2 were carried out.

In the varietal trials, the varieties Native Tanganyika, Tennesse White and the Improved Spanish 2-B were found superior. Over 275 pure lines were tested in comparative trials, and selection 193 was found promising.

Over 1400 F_3 families and 179 F_2 families were studied. Inheritance of characters, such as habit, branching, leaf-size, and the colour of the seed-coat, were studied. Correlation studies revealed that plants possessing proportionately short main axis when compared with their primary branches yield well. This is a very important and useful observation in a crop the produce of which is underground.

In BOMBAY, the cultivation of groundnut is reported to be spreading in the South Central districts, though the tendency during the year has been not to increase the area under the Spanish peanut variety owing to the fall in its prices. The Department has evolved two new erect varieties from the spreading groundnut, and these are found very promising when compared with the

spreading varieties. Observations were continued on the effects of groundnut and *juar* rotations on cotton and have once again shown the superiority of the groundnut rotation. In the Southern Division 4,471 lbs. of Spanish Peanut strain 5 and 436 lbs. of Pondicherry strain 8 were distributed to ryots.

Under the jute restriction scheme in BENGAL, the cultivators were recommended to grow groundnuts as an alternative crop, and as a result it is now fairly well established in Bengal. In varietal trials, Madras type 18 (Satara) and Gudiyattam have proved superior.

In the UNITED PROVINCES, selection has disclosed three early-maturing and erect strains, *viz.*, Nos. 18, 23 and 24, which yield 22 to 28 maunds per acre against 20½ maunds of Akola-10 which is popular in many localities. In the CENTRAL PROVINCES where groundnut is now extensively grown in rotation with cotton, over twenty thousand pounds of improved seed were distributed. The new strain A K 8-11, which is easily harvested and gives 4 to 6 per cent more seed on shelling, is expected to supersede the existing strains. In the PUNJAB, a new variety, D-3, has come into prominence. In SIND, varietal trials are in progress and a spacing of $2' \times 1'$ was found advantageous. In BURMA, branching and non-branching selections have been obtained. The sowing of groundnuts in "lines" and "squares" has been extended. Inter-sowing of groundnut with red gram gave extra income of Rs. 5 to Rs. 10 per acre, and the yield of groundnut was not affected. In the HYDERABAD STATE, varietal trials and experiments to determine correct spacing and the right time for planting are in progress.

Sesamum. To estimate hybrid vigour, F_1s were studied at PUSA. In BURMA, the principal sesamum-growing province, crosses have been made between Palestine and Burmese types with a view to raise the oil-content. In varietal trials, the variety Mahlaing Yegyan was found superior at Tatkon. The method of sowing in lines was demonstrated in over 20,000 acres. Over 4,000 lbs. of improved seed was distributed. In the UNITED PROVINCES, early-maturing white-seeded types were found superior. In the CENTRAL PROVINCES one late and three early-maturing selections have shown

very good performance. In the PUNJAB, the type 5 (white-seed and high oil-content) has been crossed with a number of other high-yielding varieties. The varieties at Sakrand, SIND, were completely destroyed on account of root-rot and sepaloid malformation.

Rape and Mustard. Almost half the acreage of these crops in India is in the UNITED PROVINCES (2·5 million acres), the other important provinces being BENGAL (0·71 million acres), the PUNJAB (0·7 million acres) and BIHAR and ORISSA (0·55 million acres).

At Karnal selections were made in self-fertile types of *sarson* (*Brassica campestris*) and *rai*. In the UNITED PROVINCES, where very heavy damage results from periodical aphis attacks, selections 3, 5, 9 and 11 are found definitely superior in yield and resistant to aphis. The type 11 has given the highest yield of over twenty-six maunds to the acre against 13¾ maunds of the local. The sowing of the crop before the middle of October gave higher yields. In the PUNJAB a special technique has been developed to distinguish the seeds of *toria* (*Brassica napus*), *sarson* and *rai*. The mustard, O B 1, which is frost-resistant and self-fertile (can be kept pure), gave an average yield of thirty maunds per acre under rain-fed conditions. In SIND, the first fortnight of November has been found to be the optimum period for rape sowings. A Bengal type of rape is found high-yielding and most resistant to aphis attack.

Linseed. On account of the large Argentine crop in 1934-35 the prices of linseed in India remained low till the middle of December 1936, when the poor crop prospects in Argentine led the Argentine Government to raise the basic price payable to farmers. The price which ranged between Rs. 6-8-6 to Rs. 7-0-0 per cwt. at Bombay during April to December responded quickly to the action of the Argentine Government and rose to Rs. 7-9-0 in January and remained above Rs. 7-0-0 till the end of March 1936. Indian prices were above export parity owing to keen home demand, and the exports in 1935-36 were therefore less than in 1934-35.

The CENTRAL PROVINCES and BERAR (1·08 million acres) is the principal linseed-growing province in India. The other important areas under linseed are the UNITED PROVINCES (0·84 million

acres), BIHAR AND ORISSA (0·54 million acres) and the HYDERABAD STATE (0·41 million acres).

At PUSA, the study of the crosses between rust-resistant and rust-susceptible varieties was continued. Hybrid type 12 was found superior to the other six hybrids. In the UNITED PROVINCES linseed has been in the past an uncertain crop to grow chiefly due to losses from rust attack, but the distribution of immune, high-yielding types has made it possible to grow pure linseed crops. The United Provinces Government have subsidized single crop linseed areas. Mid-October sowings are found superior to mid-November sowings. Two and three irrigations increased yields by 2 and 3½ maunds respectively.

In the CENTRAL PROVINCES, the strains evolved from crosses between E B 3 and a Punjab type have yielded about forty per cent more over the small-seeded local variety. As the seed of the selections from the progeny of the crosses between E B 3 and Russian flaxes is not " bold ", some of these have been back-crossed with the bold-seeded parent E B 3.

In BIHAR the purity of the wilt-resistant type Sabour 6 has been established, but it is susceptible to rust. In Upper ASSAM valley 10,235 lbs. of linseed were distributed for seed purposes. Varietal trials were in progress in Assam. In the PUNJAB, types 5 and 23 have given higher outturns than the local and Pusa types. In SIND, Pusa varieties H 12 and H 16 appear to be well suited and the crop sown in early November gave the highest outturn. In BENGAL selection 26 has proved superior. In experimental sowings of linseed in BURMA, a maximum yield of 660 lbs. per acre was obtained. In BOMBAY, work on linseed-breeding has been undertaken with the help of funds provided by the Sir Sassoon David Trust. Selection work is in progress on the local material and the promising single plant selections are being tested for content, and drying quality of the oil. Trials have also been undertaken on a number of pure strains from outside the Presidency, some of which appear to be of value for hybridization. Twenty-one promising selections have been obtained.

Castor. More than half the area under castor is concentrated in the HYDERABAD STATE (834,000 acres), the next important province being MADRAS with 257,000 acres.

In HYDERABAD STATE, selections have been made which are superior with regard to oil-content and yield. In Madras the results of continued in-breeding did not show any deterioration. Fifty economic types were selected from among the progenies of crosses. A number of decorative types have been evolved by hybridization. In BOMBAY, trials were continued with the two types (Nos. 20 and 5) of castor which had been found promising, and a selection from No. 20 has been found to be high yielding and early. This is being tested in replications. In the CENTRAL PROVINCES 45 types have been isolated. Dwarf Surat and Dwarf Thana varieties are found most suitable for SIND. Early sowings were more economical than the late sowings. In Gujarat the strain S 20 has been found superior.

Coconut. In MADRAS, artificial pollination did not increase the yield of the coconut. The plots receiving ammonium sulphate and ashes yielded twenty-three per cent more than the control. It was found that high yielders on the whole produce more copra per nut than the poor yielders. During the year, 7,343 seed-nuts and ninety seedlings were distributed. Cultural and manurial experiments and demonstrations were continued in TRAVANCORE.

Safflower. At PUSA the progeny studies of the crosses were continued. In MADRAS Pusa types 1 and 28 appeared superior to the remaining Pusa types. Selection work was continued in seven types found suitable for SIND.

9. Tea

OWING to the limitations imposed under the *Indian Tea Control Act*, the toal area under tea in India has undergone but little change, being 839,000 acres exclusive of Burma.

The total crop produced in India during 1935-36 was not limited under the Act. Only the amount exported from India was

controlled, which amounted to 310,965,875 lbs. up to 31st March 1936. It was distributed as indicated below :—

	lbs.
North India by sea	261,940,701
North India by land	1,294,806
South India by sea	47,730,368

This export quota represents the amount recommended by the International Tea Committee on the basis of 82·5 per cent of the basic year crop. For the year 1936-37 the International Tea Committee have recommended the same quota. Coincident with the operation of the restricted exports, stocks of tea in the bonded warehouses in London have fallen as shown by the following figures which are the stocks of tea in lbs. at the end of February for the years 1934, 1935 and 1936.

	lbs.
London stocks at the end of February—	
1934	283,261,000
1935	298,451,000
1936	262,392,000

Whilst stocks have fallen, the prices realised in the London auctions have improved. The average price for all teas in London was, in—

	d.
1933	11·70
1934	13·27
1935	12·90

which compared well with 9·45*d.* realised in 1932, which was the lowest figure reached in the years of depression.

The corresponding prices realised in Calcutta were for all teas :—

With export rights

	AS.	P.
1933-34	9	7
1934-35	8	9
1935-36	9	5

For internal consumption

	AS.	P.
1933-34	4	10
1934-35	5	2
1935-36	4	10

Whilst the export of tea has been under control in the large producing countries, there has at the same time been an intensive propaganda to increase the consumption of tea. India's financial contribution to this has been collected through the operation of the Indian Tea Cess Act and has amounted to a sum of 21·5 lakhs of rupees, of which twelve lakhs were allotted for the purpose of tea propaganda in India.

The consumption of tea in India has for a number of years been steadily increasing.

Consumption of tea in India

	Million lbs.
1933-34	66·0
1934-35	70·0
1935-36	87·7

The above figures include the consumption in Burma. It is estimated that the consumption in India exclusive of Burma amounted to seventy-three million lbs. in 1935-36. Whilst this steady rate of increase is satisfactory, yet it is very evident that the total amount of tea consumed in India is very small *per capita* of the population when compared with the consumption *per capita* in countries like Great Britain, Canada or Australia.

With the present permissible export quota, tea estates have been able to produce the allotted crop by plucking only a portion of the tea acreage and attention has been turned to the production of the required crop by more intensive cultivation on smaller areas with the object of reducing the cost of production.

In the previous report attention was drawn to the fact that nitrogen manuring gives an increase in crop approximately proportional to the increase of nitrogen given and that sulphate of

ammonia appears to be the most efficient form in which to supply the nitrogen, which can be ascribed to two causes—

(*a*) the ready availability of the nitrogen,

(*b*) the increase in soil acidity and improvement of the physical condition of the soil.

A certain amount of fear has often been expressed that the continual use of mineral manures may result in a deterioration of the cropping capacity of the tea bushes. An experiment at Tocklai, that has now been continued for sixteen years using the same manures every year on the same plots, has given in 1935 the following crop returns :—

Manure	Crop; mds. tea per acre
No manure	5·01
Sinews and hides	6·50
Nitrate of soda	8·58
Rape cake	9·66
Green cuttings of *Tephrosia candida*	10·18
Sulphate of ammonia	11·22
Significant difference (P=·05)	1·23

The sulphate of ammonia gives the largest crop and is on the verge of significance from the crop given by the cuttings of *Tephrosia candida.* There is then no indication, rather the reverse, that the continued use of sulphate of ammonia will lower the cropping capacity.

Sulphate of ammonia has proved more efficient than other manures tried. It has greatly increased the soil acidity. There is no loss of tilth, but on the contrary it has been demonstrated by physical tests that the friability of the soil has been improved.

Oil-cake and *Boga medeloa* cuttings also yield alike within experimental error.

As in other trials, rape-cake is not as efficient as sulphate of ammonia. There is no loss of tilth in the soil to which the rape-cake has been applied, but no improvement can be demonstrated.

The green cuttings of *Tephrosia candida* do well. This is a rich material containing one per cent of nitrogen in the fresh cut-

tings or about three per cent in the organic matter. Such nitrogen is rapidly and efficiently available. It is unlikely that any benefit would arise by composting of such material. Here again no improvement in tilth or in the organic matter content of the soil can be demonstrated.

The continuous application of nitrate of soda has spoilt the tilth of the soil, as has been demonstrated by physical tests. In early years the nitrate of soda did as well as the sulphate of ammonia. Plots to which sinews and hides have been applied continuously have also lost tilth and this is ascribed to the formation of an organic protective colloid. The main cause of the inefficiency of this material, however, must be the non-availability of the nitrogen.

It has also been suggested that the continued use of a mineral manure will result in the depletion of the soil of organic matter. An experiment now in progress at Tocklai is of particular interest in this connection. The experiment was commenced in 1930—only mineral manures have been used. Those plots which have received annually 80 lbs. and 120 lbs. of nitrogen per acre respectively now show a significant increase in the amount of soil organic matter as measured by either (*a*) loss on ignition, or (*b*) the total nitrogen. This may seem to some unacquainted with tea culture in Northern India a somewhat extraordinary result but which can be explained simply :—The use of mineral manures supplying a suitable and readily available nitrogen has caused the tea bushes to grow vigorously so that the amount of leaf-fall and prunings which can be annually buried in the soil are increased, as the amount of nitrogen added as manure is increased. This is shown by the figures obtained from the experiment.

Manuring : lbs. nitrogen per acre	Green weight of prunings buried : tons per acre
0	2·86
40	4·10
80	5·41
120	6·36

There was no significant difference in the consumption of the prunings with the different manuring, all averaged within the sampling error—

	Per cent.
Organic matter	35·0
Ash	2·2
Water	63·0
Containing nitrogen	0·66

Each forty lbs. of nitrogen given annually as manure have very approximately given annually an additional 1·2 tons per acre of green prunings containing 0·4 ton of dry organic matter.

The supposition very commonly expressed that the use of mineral manures must exhaust the soil is clearly not the truth for tea in North-East India.

It has often been claimed that the uses of organic manures are preferable to mineral manures because they are slow-acting. An experiment carried out at Tocklai with an application of twenty tons per acre of cattle manure containing approximately 160 lbs. of nitrogen does not support this supposition, for the results show that the cattle manure gave a crop-increase for four years only, after which the crop became approximately the same as from the unmanured areas. Another area manured with 160 lbs. nitrogen as sulphate of ammonia showed that the sulphate of ammonia had a residual effect during four years.

The application of a manure has usually been accompanied by some form of cultivation to bury the manure. The results of the experiment at Tocklai show that the same crop is obtained whether sulphate of ammonia is buried or allowed to remain on the surface of the soil.

Treatment	Crop: mds. per acre
Manure broadcast on March 25, soil not cultivated until May 20	13·74
Manure broadcast on March 25, and covered at once by a light cultivation	13·61

The tea plant in North-East India when allowed to grow naturally and undisturbed by pruning and plucking has alternating periods of growth and dormancy. The number of growth-periods of one terminal bud during one season does not exceed five and is less in most cases.

If a bush is pruned and then left to grow unplucked for the rest of the year, the growing periods of the pruned bush do not necessarily correspond with the growing periods of a similar bush which has never been pruned, but the crop-production of a bush which is plucked at regular intervals has been shown to be associated with the growing periods of a similar pruned but unplucked bush. The physiological activities of the tea bush can be correlated with its growing periods. Response to pruning and plucking, the density of the number of hairs on the back of the leaf and the chemical composition of the leaf are correlated with the growing periods. The sum total of changes in all these factors must have a reflection in changes in the quality of the manufactured tea.

Experiments carried out in various tea gardens have shown that both Burgundy mixture and lime-sulphur solution exercise a control over the development of disease known as Black Rot (*Corticium invisum*) when the spray is applied at a time when the disease is seen to be present. In North-East India spraying during the cold weather exercises but little control. Of the two sprays, Burgundy mixture has proved to be the more efficient and it is effective at one per cent strength. Stronger solutions up to four per cent have a greater effect upon the disease, but the difference between the four per cent and the one per cent Burgundy solution does not seem sufficient to warrant the heavier expenditure.

The Shot-hole Borer (*Xyleborus fornicatus*, Eich), which is recognised as one of the most serious pests of tea in Ceylon, is not a noticeable pest of tea in India. For some time it was supposed that this insect did not exist in tea in India. In 1926 Beeson published a record of all the localities in India where *X. fornicatus* has been found. He, however, stated in his publication of 1930 that there is no authentic record of this species from tea in India, although it actually occurs in some of the tea-growing districts.

Specimens of borers recently sent for identification to the Imperial Institute of Entomology leaves no further doubt that the insect is present on tea in South India. Its presence has so far been reported from only one tea estate. Having determined that this pest does occur on tea in central Travancore and realising that it may be very difficult or even impossible to keep this insect under control if once it is allowed to establish itself, it is highly desirable that estates on which this pest is found to occur should make every effort to eliminate it.

In South India the early part of 1935 continued dry and steady rains only began at the middle of June. August and September were characterised by frequent and light rain but November was almost rainless and there were only two small showers in December and no more until the early part of February in 1936 when there were two storms. Throughout the year the annual rainfall was much below average but the distribution was on the whole good.

The climatic conditions in Southern India differed somewhat during the early part of the year, but the drought at the end of the year occurred in both North-East and South India. Rainfall in the early part of the year in North-East India was nearly normal except during April when only half the normal rain fell. June and July were more than normally wet. During October only 0·15 inch of rain fell as compared with 4·32 inches, the average for this month for the past eighteen years. The dry conditions continued so that in December the soil moisture percentage reached the record low figure of eight per cent at Tocklai. Rainfall became normal with the new year, but the soil continued to remain abnormally dry and conditions of severe drought continued to prevail during the first three months of 1936.

10. Coffee

THE coffee-growing industry of India is confined to Southern India, comprising the Madras Presidency, the Mysore State, Coorg, Cochin and Travancore. The total area of reporting plantations in 1935-36 was 335,115 acres, as compared with 328,199 acres in the

preceding year. But the area actually under coffee in the reporting plantations in the year under review was 188,035 acres as compared with 185,670 acres reported in the preceding year. New land planted with coffee during the year amounted to 4,497 acres, while the area of old cultivation abandoned was 2,132 acres. Of the total area under coffee during 1935-36, Mysore accounted for 55 per cent, Madras 23 per cent, Coorg 21 per cent and Cochin and Travancore together one per cent.

The production of cured coffee was estimated at 40·9 million pounds as compared with 32·7 million pounds in 1934-35, the yield per acre of plucked area being 318 lbs. in Madras, 278 lbs. in Coorg, 251 lbs. in Travancore, 199 lbs. in Cochin and 192 lbs. in Mysore. The figures for 1934-35 for these localities are respectively 201, 241, 167, 126 and 187 lbs.

The exports of coffee increased from 141,000 cwts. valued at Rs. 73 lakhs in 1934-35, to 216,000 cwts. valued at Rs. 102 lakhs in the year under review, the principal markets for Indian coffee being, as usual, the United Kingdom and France. In spite of a decline in Brazilian production in 1934-35, visible world supplies remained at a relatively high level. The price of East India Superior Coffee in London remained steady at 120*s.* per cwt. from April till about the middle of January. Thereafter the price fell by 10*s.* and the rate remained at this level till the end of February. In March, however, there was an increase to 115*s.* 6*d.*

An important event affecting the coffee industry in India was the passing of the Indian Coffee Cess Act in November 1935, " to provide for the creation of a fund to be expended by a committee specially constituted in this behalf for the promotion of the cultivation, manufacture and sale of Indian coffee ". The Act extends to the whole of British India, except Burma, and provides for the levy of a customs duty on all coffee produced in India and exported therefrom to any place beyond the limits of British India or to Burma at the rate of one rupee per cwt. or at such lower rate as the Governor-General in Council may lay down on the recommendation of the Indian Coffee Cess Committee which has been constituted under the Act. The rate of cess now leviable is eight annas per

cwt. A committee, known as the Indian Coffee Market Expansion Board, has been set up in the United Kingdom with the Indian Trade Commissioner as its chairman to carry out propaganda for increasing the consumption of Indian coffee in the United Kingdom.

As in previous years, research work on coffee was centred at the COFFEE EXPERIMENTAL STATION, BALEHONNUR, in Kodur district, Mysore State, the Station being maintained by the Mysore Agricultural Department with the co-operation of the United Planters Association, South India. Breeding work on coffee was continued on the usual lines. Over 13,000 seedlings are now available for further work and some more selections are being made from a few promising families which have come to a bearing age. The second generation of seedlings of a few such families were under trial. Under vegetative propagation pure *Arabica* grafts on hybrid *Arabica* thrived well. Work on propagation by cuttings indicated that good plants could be produced by doing the work from February to April and from July to September. Comparative studies of the root systems of the resistant hybrid and the susceptible *Arabica* plant growing under identical conditions revealed marked differences in the degree of root development and penetration.

Experiments on coffee manuring were continued. The lay-out of the plots to minimise marginal effects was completed. Some of the remodelled experiments have now run for three years and a study of the results will be made to see if the remodelling has been effective. Studies on the distribution of plant foods in the coffee bush have emphasised the necessity of an adequate supply of potash. It is also observed that a proper development of the berry is influenced by a particular nitrogen-carbon ratio in the plant.

The investigation of Leaf-Disease of coffee was continued, and comprised the study of resistance and susceptibility of coffee strains, germination of teleutospores and the influence of plant nutrients on the development of infections. Progress was made with the study of the ' Die-back ' disease and the results have confirmed the conclusions already arrived at, *viz.*, that ' Die-back ' is primarily a secondary disease following unfavourable conditions and that some

preceding defoliation is a predisposing factor. Work on the studies of fruit-setting and fruit development was in progress. Work on spray materials and methods indicated the possibility of omitting an adhesive or spreader without in any way decreasing the efficiency of spraying. There are also definite indications that in certain localities the pre-monsoon spray is important and that the second spray is not quite essential. An investigation on the insecticidal properties of certain local plant-products was conducted with the help of a grant from the Imperial Council of Agricultural Research and gave promising results. Of the thirty-three plant substances examined, two have been selected for further extensive field trials. The use of coal-tar distillate emulsion against Coffee Stem-borer proved effective. Ninety-five gallons of material were distributed in Kadur and Hassan districts. It is reported that the attack in the treated areas decreased by fifty per cent.

Studies on the quality of coffee have been undertaken with the financial assistance of the United Planters Association of South India.

With the appointment of an Agricultural Meteorologist, studies on the soil-moisture, periodicity and rate of growth of coffee in relation to weather conditions and rainfall have been taken up.

11. Rubber

RUBBER is grown mainly in Southern India and Burma. The total area under rubber was 228,841 acres, an increase of about one per cent over the area of the previous year ; and of this area 187,151 acres were tapped during the year. Of the total area under cultivation, 47 per cent was in Burma, 42 per cent in Travancore, 5 per cent in Madras, 4 per cent in Cochin and 2 per cent in Coorg and Mysore together. The total production of raw rubber during 1935 was 48,545,045 lbs., as against 37,156,317 lbs. in the previous year. The yield per acre of tapped area was 199 lbs. in Coorg, 242 lbs. in Travancore, 275 lbs. in Cochin, 243 lbs. in Madras and 283 lbs. in Burma. The export of rubber by sea from India during 1935-36 amounted to 34·7 million lbs. as compared with 25·9 million lbs. in the preceding year. Of the total exports, the United

Kingdom absorbed 32·7 per cent, the Straits Settlements 22·3 per cent, Ceylon 20·2 per cent, Italy 7·2 per cent, Germany 6·1 per cent, the United States of America 4·3 per cent and Czechoslovakia 4·1 per cent.

The international scheme for the regulation of production and exports of rubber came into operation from 1st June 1934, the basic export quota being fixed at 7/12th of 6,850 tons for India and 7/12th of 5,150 tons for Burma. The basic quota for 1935-38 was as follows :—

—	1935	1936	1937	1938
	Tons	Tons	Tons	Tons
India	12,500	12,500	12,500	13,000
Burma	8,000	8,500	9,000	9,250

The average declared value per lb. of exports rose from four annas five pies in 1934-35 to four annas seven pies in 1935-36.

No research work was carried out on rubber during the year, the Rubber Experimental Station of the United Planters Association, South India, at Mundakayam, being still maintained on a care-and-maintenance basis.

12. Fruit

DURING the year under review, horticultural development in India was rapid. The Imperial Council of Agricultural Research assisted various provinces and Indian States to develop their fruit experiment stations. A large number of new fruit nurseries are springing up in different parts of India. There is also a definite increase in the acreage of fruit cultivation in some provinces.

The Imperial Council of Agricultural Research has invested Rs. 7,94,562 up-to-date as initial expenditure in establishing fruit experiment stations and in equipping laboratories and has provided funds for a recurring annual expenditure amounting to Rs. 1,40,147. The provincial departments have, on their part, reorganised their fruit research and development work. Every important fruit tract is being properly surveyed and its requirements are being studied.

Propagation. Improvements in the methods of propagation have received attention. In Madras, a suitable citrus stock, *Gaja nimha* (*citrus limonia*, Osbeck) has been selected and the proper season for its successful budding has been determined. At Conoor, apples and pears were successfully grafted in stocks of other genera and species. At Chaubattia in the United Provinces, top-grafting of apples in September has been found to give ninety per cent success. Further, in the matter of selection of stocks for oranges, Katha, Sylhet and Jamburi were found to be very suitable stocks. At Poona, top-working of mango trees by detached scion and layering of guava seedlings were in hand with interesting results. In the PUNJAB, mango budding has given important results, which, if successful on a large scale, will save the expensive, tedious and cumbersome process of grafting. At Sabour in BIHAR the grafting of Singapore papaya on other stocks was attempted. In ASSAM, propagation by etiolation was tried in place of grafting for almost all trees. At QUETTA, the work on vegetative propagation of stocks was continued. Layering under the local conditions, being not so successful, has been substituted by the stooling method with satisfactory results.

Improvement of fruit crops by breeding, selection and artificial pollination. Experiments in the improvement of fruit crops by breeding and selection are few in India. A beginning, however, has been made at some places and useful strains of fruit crops have been evolved. In BOMBAY, improvement of the pomegranate (*Punica Granatum*) and guava (*Psidium guava*) by selection is recorded. At Chaubattia in the UNITED PROVINCES cross-pollination of shy fruiting plums was taken in hand. In the PUNJAB, research on the pollination of grape vines is in progress.

Physiological and cultural observations. At Sabour in BIHAR experiments were carried out in the planting of mango grafts of various ages and by different methods. Mortality was found to be higher in February planting than in August. The growth of mango trees in clean cultivation was better than under grass. Trees under clean cultivation are characterised by late leaf-fall and late commencement of flowering followed by a correspondingly late anthesis and late setting of fruit. Clean culture also shows a

tendency to development of longer internodes per shoot and greater leaf-area. Experiments in the problem of periodicity in bearing of mangoes were undertaken at Kodur and Sabour. At the latter place, the subject was studied from various points of view, *viz.*, morphological, physiological and ecological in respect of the Fazli, the Langra and the Bombai varieties of mango. It was found that there is a specific hour and day for the maximum anthesis in each of the varieties examined. Low humidity and high temperature prior to the flower-bud initiation were found to hasten the flowering period. Further, the flowering and the fruiting of the previous season were found to have a profound influence on flowering and fruiting in the subsequent season. Operations such as smudging, root pruning, girdling and ringing were found to suppress vegetative growth and increase flowering. Artificial feeding with Sachs' nutrients accelerated both growth and flowering. Irrigation given after the formation of panicles reduced fruit crop and increased the size of the fruit.

In BOMBAY, manurial trials were in hand in respect of the mango (*Mangifera indica*), the Mosambi (*Citrus sinensis* var. *mosambi*) and the banana (*Musa sapientum*). In the last case, a mixture of farm-yard manure and castor-cake giving 0·4 lbs. nitrogen in each form gave promising increase in yield. The furrow system of irrigation was observed to economise labour although the quantity of water required for the irrigation of the crop was slightly more. In the PUNJAB ringing of grapes has shown that maturity can be hastened by at least fifteen days. The umbrella system of training was found to be the best out of the ten systems followed. Phalsa pruning experiments indicated that the bushes headed back to three to four feet gave the highest yield. Fertiliser experiments on Malta oranges indicated that a four lbs. dose of sulphate of ammonia gave the best results. At Chaubattia in the UNITED PROVINCES pruning experiments on apples were undertaken to see if by modifying the shape of trees, hail damage could be mitigated. Further, an experiment was laid out to study if by heading back and applying different manures in different doses peaches could be rejuvenated. Apple trees are also being studied to see if rejuvenation of old trees

could be effected. It was observed that old apple trees can be brought round to a state of vigour by means of top-working or some such method. So, using ' Delicious ' as the scion, the effect of grafting on different ages of trees, the effect of season on grafting and the effect of different methods of grafting on the tree were studied in detail. In BENGAL, experiments on the Malta orange with different doses of lime were in progress. In SIND, investigations regarding trellising and pruning of grape vines were undertaken. In BALUCHISTAN training of pears by the cordon method was found to be satisfactory.

Harvesting, marketing, storage and preservation. In the matter of disposal of fruit after harvest, work of a premier nature is being done at the Cold Storage Research Scheme at Poona in the BOMBAY Presidency. During the year under report, it was observed that most chemicals and wrappers do not help to prolong the life of the mango in storage appreciably. The results show that the longest commercial storage life of Alphonso mangoes of ' B ' stage of maturity is sixty days at 45°F., fifty-five days at 48°F., and forty-eight days at 52°F. It is thus more or less conclusively proved that a range of 45°F. to 48°F. is the best for the storage of the Alphonso for fifty to sixty days. Besides this variety, the Peter from Madras, the Fazri Jafrani from the United Provinces and the Pairi, Cawasji Patel and Fernandez varieties from Bombay were also found to be good keepers. The cold storage behaviour of Nagpur oranges at three different stages of maturity, *viz.*, green, turning and yellow, was studied with the result that fully ripe and yellow oranges keep well at 40°F. for three months without any appreciable wastage. The storage trials on potato seed show that a range of temperature between thirty-five and 40°F. stores seed potatoes well for a period of eight to ten months.

Storage trials were also carried out in BURMA in respect of mangosteens, oranges and sweet limes. For the mangosteens the most suitable temperature is found to be between 40° and 60°F.

In the PUNJAB, the method of wrapping fruit in water-proof butter-paper at room temperature gave most satisfactory results.

The fruit could thus be stored for one month longer than the unwrapped fruit.

The Imperial Council of Agricultural Research gave a special grant to the Punjab Department of Agriculture for work on fruit and vegetable preservation. The rural reconstruction scheme of the province also sanctioned a grant of Rs. 15,000 for the construction of a canning hall. Recipes for preparing lemon and orange squashes and lime cordials have been worked out. The preparation of tomato ketchup was standardised. Formulae for the canning of pears and preparation of grape juice and wines were also worked out. The article on the 'Utilization of Oranges and Limes' in *Agriculture and Livestock in India* for March 1936 show that in regard to the utilization of oranges and limes, only the best fruit when it has the highest sugar-content and richest flavour should be used. The juice after extraction should be deaerated and not allowed to come in contact with air. Only terpene-less lemon oil or orange oil of 0·005 per cent strength may be used for flavour. The ratio of acid to sugar may be 1 to 7·14 per cent. Sulphur dioxide gas and sodium benzoate can be used as antiseptics, but not exceeding 0·05 per cent in amount. Iron and copper containers have been found to be definitely harmful.

Pests and diseases. The problems of fruit pests and diseases were also tackled to a certain extent, though investigations on this subject are scanty.

At Chaubattia in the UNITED PROVINCES, there are special entomological and mycological sections and they have carried out important investigations of pests and diseases found to attack principally apples and peaches. The percentage attack of the apple trees by the major pests were as follows:—

	Per cent
Apple Root-borer	6·44
Wooly Aphis	21·79
Rutelid Defoliating Beetles	25·62
Tent Caterpillar	1·00
Apple Leaf-roller	0·96
Apple Stem-borer	0·69
Apple Shoot-borer	0·79

It is found that para-dichlorobenzene is more effective than carbon bisulphide in the control of apple Root-borer, but the exact dose and range of application are yet to be determined. The best and the cheapest control measure for the Tent Caterpillars appears to be collection and destruction of the egg masses which encircle the twigs. The stem-borer is effectively combated by treatment with carbon bisulphide in cotton plugged into the bore which is subsequently closed with clay. The Defoliating Beetles have been kept in check by the insertion of carbon bisulphide at the rate of half an ounce per plant in the holes in the soil. The fungoid diseases met with in the cultivation and storage of apples and other fruit are also being studied.

An investigation on the citrus diseases in the PUNJAB was carried out in the Botany Department of the Punjab University with the help of a grant from the Imperial Council of Agricultural Research and the results published in the *Indian Journal of Agricultural Science*. The major disease of the *citrus* in the Punjab, *viz.*, 'wither-tip' caused by *Colletotrichum glœosporioides* Penz. was studied in detail. Investigations were also made into the 'chlorosis' of Malta and sooty-mould incrustations of citrus leaves and fruits. Experiments were conducted with various proprietary fungicides and spray mixtures and control measures have been formulated.

In BURMA, gummosis in citrus is cured by the scraping off of the affected tissues and the application of Bordeaux paste.

A survey of the fruit diseases in BALUCHISTAN has been made and common remedies suggested.

A great deal of damage to fruit crops and vegetables is done by pests and diseases. The question of the control of these therefore requires greater attention than what has been given at present.

Organisation. In BOMBAY, the Fruit and Vegetable Market Committee's Report of 1934 has already led to the appointment of a Provincial Fruit and Vegetable Market Committee to study and encourage fruit trade in the province. In the UNITED PROVINCES, a Fruit Development Board was established and a technical expert appointed to work in co-operation with the Board and to assist in the lay-out and improvement of orchards and

marketing and preservation of orchard products. The Fruit Development Board has twenty-four district associations with a membership of 1,000 affiliated to it.

13. Fodder Crops and Grasses

THE fodder and forage crops continued to receive attention at the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, PUSA. Berseem (*Trifolium alexandrinum*) is grazed or fed green from December to April, and as hay or silage at other times of the year. Very good silage can be made if it is ensiled mixed with oat-straw or green oats in the proportion of 3:1 by volume. In this process the loss due to moisture was about thirty-five per cent. Berseem is likely to be an important factor in the future improvement of dairying and cattle-breeding in India.

Elephant Grass (*Pennisetum purpureum*) and Guinea Grass (*Panicum maximum*) gave heavy yields, and trials with them are being continued.

At PUSA, green maize formed one of the chief fodders for the breeding herd. Grown under irrigation, early maize was fed in May. Unirrigated maize was cut for silage in September. The loss in making maize silage was about thirty-three per cent.

Soya-bean (*Glycine hispida*) also occupied an important place in the grazing cycle for the milch herd, as it was green in November when no other legume was available for grazing.

Work on fodder grasses at PUSA has shown that the imported grasses do well only in the monsoon at the same time as indigenous fodder grasses are in abundance.

PUNJAB. The year 1935-36 was not favourable for the breeding of late-maturing varieties at the Botanical Sub-station, Sirsa, due to the early cessation of monsoon rains and the extremely low rainfall in the succeeding winter coupled with the paucity of irrigation water at the flowering and fertilization period of *rabi* crops.

Juar (*Andropogon Sorghum*) strains J S 20 and 21, which had given very promising results in the previous years, were further tested. The results of wide-spread trials supported the previous conclusions, and these varieties were found to be superior to the

local types. Cross-breeding between good strains is in progress. Final trials on unirrigated land at Rawalpindi showed J S 21 to be the highest yielder of all the varieties under experiment there. It can, therefore, be safely concluded that these types are a definite improvement on the local *juars*.

Sudan grass (*Sorghum halepense* var. *Sudanensis*) increased in popularity still more, and the demand for its seed went up considerably.

Efforts were made to give cowpeas FO S 1 (*Vigna Catjang*) widespread publicity. Demonstration and observation plots were laid out on farmers' lands at a large number of places spread all over the province. Reports received were very favourable and the general consensus of opinion was that cowpea FO S 1 was a nutritious, high-yielding and vigorously growing crop. A mixed crop of maize and cowpeas was found to be the best for early sowings.

Teosinte (*Euchlœna mexicana*) is an exotic crop which has suited the Punjab climate very well and can be cultivated successfully especially in the irrigated tracts. Both alone and in mixture with Velvet beans (*Stizolobium deeringianum*), it has given very heavy yields of nutritious green fodder during the second transitional period, that is in November. Yields of 400 maunds and above are quite common. It is hoped that it will prove a very valuable addition to the Punjab fodder crops. Velvet beans, in addition to being rich in protein, contain a high percentage of mineral matter. They are exceptionally high in phosphorus, calcium, iron and iodine. They are, therefore, very suitable for feeding to growing stock.

Further tests with the promising selections of *meth* (*Phaseolus aconitifolius*) were continued. Two strains gave exceptionally good results and yielded more than 300 maunds of green fodder per acre. An experiment in the cultivation of Sunflower (*Helianthus annuus*) as a source of green fodder at all times of the year, was carried out. It was found that it is available all the year round, if monthly sowings are made, but the fodder is poor in palatability due to the presence of stiff hairs on the vegetative parts.

Experiments with cultivated and pasture grasses were expanded and continued. Guinea grass was studied regarding its variation

in yield, chemical composition and development of roots under a system of repeated cuttings at different intervals. It was ascertained that the highest yield was in the case of the two-monthly cuttings, while the best root-development took place in the three-monthly cut plants.

Yield data on Rhodes grass (*Chloris Gayana*) were obtained. This grass is capable of giving a cutting every month except in winter. In all eight cuttings were obtained during the year with a total of 460 maunds of green grass.

There was a heavy demand for planting material of Elephant grass as this crop is gaining in popularity. In addition to its heavy yields, it can be cultivated on odd bits of land which cannot be used for other crops.

Although the cultivation of berseem is spreading rapidly in the Punjab, one difficulty with which every new grower is faced is that it does not succeed in the Punjab when sown for the first time, unless the land is inoculated with the necessary bacteria. An experiment to find out whether shaftal (*Trifolium resupinatum*), which was popular before the introduction of berseem, has any effect on the succeeding crop of the latter, yielded interesting results. A field trial carried out for two years at three different places showed that berseem following a crop of shaftal does not require inoculation and that a very successful crop of the berseem can be raised with the first sowing.

Seed of berseem found in the market usually contains a large proportion of *kashni* (*Chicorium intybus*). A method has been devised to separate the weed seed. If the mixture of seeds is put in five per cent common salt solution, the *kashni* seed, being light, floats on the surface of the solution, while the berseem seed settles to the bottom.

Comparative tests with both early and late-maturing oat selections were continued. Among the early oats, Weston and Pusa hybrid " J " gave the highest outturns, while out of the late types Fo S 1/29 out-yielded all the others. It has been observed repeatedly that Algerian and Fo S 1/29 strains of *Avena sterilis*, which are narrow-leaved, give higher yields than the broad-leaved types

when the supply of moisture is restricted. Both these varieties gave the highest yield of grain also. Various hybrids in the F_3 and F_4 generations were under study.

An improved strain Fo S 1 of *senji* (*Melilotus parviflora*) proved superior to the local type.

Japan white-leaved rape (*Brassica napus*) upheld its superiority over all other types of rapes.

Kudzu vine (*Pueraria thunbergiana*) is being tried as a soil-binder in the Kangra hills. At Sirsa, a small observation plot is under this legume. It appears to be a promising plant for fodder.

Seeds of improved fodder crops, *i.e.*, Sudan grass, cowpeas Fo S 1, Oats (Algerian, French and Fo S 1/29), berseem and Japan rape were distributed to a large number of interested people.

BOMBAY. The rotational grazing experiment at Mangadara Kuran was continued by the Economic Botanist, Bombay. A study of the yield of grass from twenty old and twenty new representative random quadrats, cut from the blocks each time a shift was made, showed that there was a slight increase in certain of the blocks. For the third year in succession, the increase in live-weight of animals corresponded with the freshness of the vegetation. The study of the marked areas of Spear grass (*Andropogon contortus*) was continued in each of the four blocks and there is a clear indication that good perennial grasses are gradually ousting the Spear grass.

Similar experiments have been started at the Gilligan Cattle Breeding Farm, Pimple, near Jalgaon; and a preliminary survey has been made of the grass vegetation at the Chinchola Kuran with a view to similar rotational grazing experiments at that place.

The Chharodi Cattle Farm is now meeting its fodder requirements from cultivated crops and most of the area intended for hay-making has been sold. Green fodder such as maize, *juar* and grasses was put in silo pits to the extent of 381,150 lbs. as against 146,406 lbs. during the previous year. Berseem was found a valuable fodder during the cold weather.

At the Cattle Breeding Farm, Bankapur, the rains were not favourable to grass-lands. 42,510 lbs. of hay was harvested as against 59,000 lbs. during the previous year. Experiments with

various types of indigenous and imported grasses have been continued, and indigenous grasses continued to give good results. Trials with *ragi* (*Eleusine coracana*) as fodder crop proved successful and cattle thrived well on it.

SIND. The determination of suitable fodder crops for the Barrage areas is one of the most important problems under investigation by the Agricultural Department in Sind. With the advent of the perennial irrigation and consequent disappearance of fallow areas which served as grazing grounds for cattle in the past, every farmer must necessarily cultivate a certain percentage of his cropped area under good fodder crops. The present tendency of the zamindars to push on the cultivation of money crops is bound to result in the degeneration of work-cattle due to lack of nutritious green fodders.

Of *kharif* crops, sweet *juars*, cowpeas (*Vigna Catjang*), *mung* (*Phaseolus mungo*) and *guar* (*Cyamopsis psoraloides*) are important. During the *kharif* season of 1935, cowpeas gave the highest yield, *viz.*, 13,168 lbs. per acre. The sweet *juars*, however, gave three cuttings during the season. Cowpeas and *mung* being legumes are valuable to the farmers as they improve the fertility of the soil. Sowing of *guar* and *mung* mixed with *juar* provides a very palatable and nutritious fodder for stock. Berseem has been found to be a very valuable crop for Sind. In addition to being an excellent and high-yielding *rabi* fodder crop much relished by all kinds of livestock, it has given very useful results in crop rotations for *kalar* (alkali) land reclamation. The area under this crop is extending, but the high price of imported seed is restricting its cultivation. Research work on its irrigational requirements, both for production of fodder and seed, are in progress at Sakrand.

The important non-leguminous fodder crops tested during the season were oats (*Avena* sp.), barley (*Hordeum vulgare*) and Russian rye (*Secale cereale*). The last named does not appear to be a prolific grower. The problem of finding out good green fodders which would be available in April, May and June, when there is a general

scarcity of green fodders, is being studied. It is proposed to test some perennial fodder crops on low-quality land.

MADRAS. As in the previous years, different fodder crops were cultivated at different agricultural stations in the Madras Presidency. At the Central Farm, Coimbatore, Elephant grass yielded the heaviest, *i.e.*, 167,850 lbs., while Guinea grass was the second best with 48,000 lbs. per acre.

The study of fodder grasses was continued. *Panicum maximum* and *Chloris bournei* gave the best yields.

The severe drought experienced during the year gave an impetus to an increase of area under fodder crops, such as *cholam* (*Andropogon Sorghum*), sann-hemp (*Crotolaria juncea*), *pillipesara* (*Phaseolus trilobus*), etc. The introduction of the *pillipesara* crop has helped a great deal in solving the fodder problem in the I and II circles, where it is grown over an area of 16,000 and 21,000 acres respectively. The introduction of Elephant, Guinea and *Kolukattai* (*Pennisetum cenchroides*) grasses, lucerne, maize, teosinte and sunflower was also continued. Hay and silage-making were demonstrated to the ryots at a number of places.

Three species of Saltbush were tried at Ootacamund. Only *Atriplex semibaccata* appeared satisfactory. Kikuyu grass (*Pennisetum clandestinum*) also gave promising results.

BENGAL. The statistical work on the green matter of cowpeas proves that the American types, Brabaham, Groit, New Era, Victor and Iron and the Chittagong type Peru gave very good results. Napier Grass has become a well-established fodder crop throughout the province and has extended largely in Bengal.

Among the pasture grasses, *Andropogon pertusus* and *Andropogon annulatus* proved superior. The evergreen character of *Panicum abyssinicum* in the driest season was confirmed.

Silage-making is spreading amongst dairy farmers, but is not popular with the cultivators so far. More fodder is now grown than previously. There has been a continued demand for cuttings of Napier Grass and difficulty has been experienced in supplying the quantities indented for. The uncertainty about the life of Elephant Grass has been removed, as fields on which the crop has

been standing for over six years have not shown any diminution in yield.

UNITED PROVINCES. Berseem, lucerne, oats, peas and shaftal were grown at the various farms of the United Provinces Department of Agriculture. The produce from these crops as well as from *kharif* crops was fed as green fodder, hay or silage.

At the IMPERIAL VETERINARY RESEARCH INSTITUTE, MUKTESWAR, increased attention is being paid to the growing of fodder crops, and particularly the supply of green fodder continuously throughout the year. The most promising fodders for this purpose appear to be lucerne, berseem, teosinte (*Reana luxurians*), Algerian oats and an indigenous grass (*Pennisetum flaccidum*) locally known as *mulsa*. As a result of three years' experimental work, this latter grass can now be successfully propagated and is proving a useful addition to the fodder supplies of the Institute.

BIHAR AND ORISSA. In order to supply green succulent food to the animals and particularly to milch cattle, all farms have of necessity to pay a good deal of attention to the cultivation of fodder crops. In the monsoon period maize, *jowar*, cowpeas, *meth*, *urd*, and soya-beans are the main cereal and pulse fodder crops. The best silage is made from maize. Elephant Grass is an excellent perennial which supplies bulky food over the greater part of the year. For the cold weather, berseem and lucerne are the two most valuable crops. Berseem can be grown throughout Bihar wherever irrigation is available and has given as high as 650 maunds of cut green fodder per acre. The analysis of indigenous fodders will be taken in hand.

CENTRAL PROVINCES. The botanical composition of the herbage of Telankheri and Richai farms was determined. The effect of different fertilisers on its growth is being investigated. Selected varieties of grasses were grown for seed distribution purposes.

ASSAM. *Rabi* crops and grasses were cultivated at the departmental farms. In the Upper Shillong farm, maize, cowpeas, soya-bean, blue grass, raishan (*Paspalum sanguinale*), Kikuyu grass and some local grasses were grown. At the Sylhet Cattle Breeding

Farm, in addition to Elephant and Guinea grasses, marrow-stem (*Brassica oleracea, Liner* var. *Acephala*) and thousand-headed *kales* (fodder cabbage) were tried. Converting the grasses into silage is now a matter of routine practice on all the farms.

In the Lower Assam valley *uridal* (*Cryza sativa* var. *Fatua*) and wild aquatic paddy were made into good quality silage which was relished by cattle.

MYSORE. Lucerne, Guinea, Rhodes and Napier grasses occupy an important place among the fodder crops in Mysore.

INDORE. A preliminary survey made in 1932 and 1934 to estimate the yield of edible grasses and weeds from natural grasslands and grass borders of cultivated fields in the Malva tract, showed that a suitable method for increasing the yield from poor grasslands—which class predominates—seems to be needed. Studies on the improvement of pastures have, therefore, been undertaken.

Lucerne is grown to a limited extent all over Malwa. Seed is sown broadcast in small flat beds. The growth is generally poor and the crop soon becomes weedy and unprofitable. Various experiments to find whether the crop required (1) manure or (2) changes in cultivation method or (3) inoculation with suitable organisms were laid out. Yield increases were obtained from increased supply of phosphates, while increased doses of organic matter had no appreciable effect. Methods of cultivation did not differ on their effect on yield. Inoculation showed a slight increase in yield, but the increases were meagre when compared with those due to greater phosphate supply. Manuring by the Indore method was also tried on this crop.

The actual cost of production of lucerne was worked out according to the new Indore method of cultivation.

Carrots and sugarbeet were compared for fodder yields, but the results obtained were not significant. In feeding value carrots are superior to sugarbeets.

Eleven varieties of mangolds were tried at Jaipur. It appears that mangolds are likely to yield better than carrots and their feeding value compares favourably. At Indore the roots of some varieties attained large size and weight.

14. Millets

THE principal millets cultivated in India are *juar* (*Andropogon Sorghum*), *bajra* (*Pennisetum typhoideum*) and *ragi* (*Eleusine coracana*). Together these occupy about fifty-seven million acres annually. Other lesser millets such as *nachani* (*Setaria italica*), *kodra* (*Paspalum scrobiculatum*), *vari* (*Panicum miliaceum*) and other panicums are more of local importance.

Juar, *Andropogon Sorghum.* The area under this crop in the British provinces and in the principal Indian States was over thirty-three million acres during 1935-36. In most of the places the acreage declined during the year under report, registering a decrease of about a million acres. The chief growing areas, in order of importance, are in the Hyderabad State, Bombay, Madras, the Central Provinces and Berar, the United Provinces and the Punjab. The estimated yield of *juar* during the year was over six million tons.

HYDERABAD has nearly nine million acres under *juar*, representing over twenty-five per cent of the total area under the crop in India. During 1935-36 the area decreased by nearly two lakhs of acres. The estimated yield for the year was 1,100,000 tons. Improvement of both *kharif* and *rabi* varieties was in progress at the Experimental Farm, Parbhani. Four *kharif* strains appeared promising, while from *rabi juars*, two tall and two dwarf desirable strains have been isolated. Out of the five different varieties compared, Ramkanke and Gadgeria continued to give better yields.

At the Dry Farming Research Sub-station at Raichur, Dagadi and Maldandi varieties from Bombay were promising, while varieties from Hagari proved rather late. Spacing experiments with a local red *kharif* variety showed that with rows 18″ apart and spacing of plants within rows at 3, 6, 9, 12 and 18 inches, the 12 and 18-inch spacings were significantly superior to the 3-inch spacings. The yield of grain increased significantly as the spacing between plants increased, but the reverse was the case with the straw yields. A similar experiment with a local *rabi juar* showed that the 12″ spacing was better in yield of grain than the control 6″ spacing, which was in turn better than other spacings but not to the extent

of statistical significance. In case of straw yields six and nine inches spacings were better, but here again not significantly. In another experiment, where plants were spaced both ways at 12, 15, 18, 21 and at 24 inches, similar results as with the *kharif juar* interplant spacings were obtained, except that, in this case, the differences between fodder yields were also not significant.

BOMBAY, excluding the neighbouring States, possesses nearly eight million acres under *juar*, or nearly twenty-three per cent of the country's total area for this crop. The estimated area in 1935-36 was 7,743,000 acres, showing a decrease of 202,000 acres over the previous year. The total yield of *juar* was 1,504,000 tons. Simple selection work is being done in various zones under the guidance of Deputy Directors. At Viramgam in Gujarat, two selections from the Chhasatio and two from Utavali *juars* have been obtained. The standard *rabi* strain 8, evolved at Broach, has been multiplied for distribution in that district. In the Surat district 15,000 lbs. of seed of the Budh Perio variety was distributed. From the Aispuri variety, four strains (17, 41, 44 and Salsingi) have been obtained at Jalgaon. At Mohol the strain 31-2 from Maldandi has given better yields over two years. Another strain, 35-1, was the earliest and may suit Bijapur.

Studies in water requirements showed that one of the three strains was distinctly more efficient in its utilization of water. The addition of farmyard manure was found to increase the efficiency of the plant to utilize water, but the presence of large quantities of water decreased efficiency and gave a high transpiration co-efficient. The " Bombay Dry Farming Method " gave better yields than the local method at Sholapur and at Bijapur. At the former place mulching on a medium deep soil gave significantly higher yields. At Bijapur the operation was significantly better in increasing yield on a bunded limy soil, but was not so highly superior on a deep black soil. The addition of organic matter to a limy soil gave a significant increase in yield at Bijapur, but was ineffective at Sholapur.

MADRAS claims nearly fifteen per cent of the total acreage under *juar* in the country. During the year under review, the estimated

area was 5,102,000 acres, showing a decline of only 41,000 acres over 1934-35. The yield of *juar* during the year was 1,370,000 tons. The chief centre of genetic improvement is Coimbatore where the Millets Specialist is in charge of the work. The white-grained summer irrigated strain, A S 1575, although early by ten days, was the best in yield and continued to spread in the Coimbatore and Salem districts. In the white-grained, Villai *Cholam* series, the new early strain, A S 2095, proved again better than the standard strain, A S 367 ; and is expected to replace the latter in Chittoor. The new selection is said to have done better at Koilpatti also. A strain, A S 732, proved much better in yield than the bulk seed of M S 3154. Among the yellows, A S 809 continued to be superior, being significantly better in yield than M S 3155. From the preliminary trials seven white-and two yellow-grained summer strains have been obtained for extensive trials.

At the Agricultural Research Station, Guntur, over 500 cultures of *juar* were under observation. It was found that the grains from the apex of the earhead yielded better than the bulk seed. At Koilpatti the strain 171 yielded twenty per cent more fodder than the local. During the year 9,729 lbs. of seed of T 1, T 6 and N 29/68 strains were distributed in the III[1] circle. It is estimated that three strains cover an area of 101,105 acres. T 6 also proved better in *pyru* season in the III circle. In the VIII[2] circle over 10,000 lbs. of seed of Peria Manjal T 1 and T 12 were distributed for fodder purposes.

Selection in local *juars* is also being done at the Dry Farming Station, Hagari. The main aim is to produce a more drought-resistant type than the present standard strain, T 1. Studies of root development showed that the loose-panicled varieties possess deeper root-systems than the compact types, which show greater lateral spread. The mature earless plants, so abundant in cultivators' fields, had the poorest root development. The " Bombay Dry Farming Method ", although better than the local, was not economic.

[1] Comprises the districts of Kistna, Guntur and Nellore.

[2] Comprises the districts of Coimbatore, Salem and Nilgiris.

The Government Agricultural Chemist, Coimbatore, initiated studies in the malting of *juar* during the year under review. Varietal differences were observed in reaching the "steep-ripeness[1]" stage. As the fatty acids interfere with the keeping qualities of malt-flour, a search was made to obtain varieties with low fat-content. Out of the twenty-five varieties analysed, six had a low content. Fractionation of fatty acids to improve the keeping quality of malt is also contemplated. Storage experiments with glass and tin containers with air-tight lids showed that malt retains its fine aroma for three months, but thereafter acidity develops. A ratio of 1:3 of malt-flour to wheat-flour was found successful in preparing cakes. Attempts are being made to evolve suitable blends for bread and biscuits. Nutritional studies are also in progress.

The UNITED PROVINCES grow annually over two million acres of *juar*. During the season under review, the actual area was 2,237,000 acres, which was slightly less than the last year. The improvement of the crop is being carried at Cawnpore, where a number of strains have been isolated. The strain 5 is drought-resistant and is suitable to Bundelkhand. The strain 8B is a good dual purpose variety. Besides these, strains 19, 23, 46 and 47 have been isolated to replace the local varieties. Sixty-three types have been botanically classified.

In the PUNJAB the area under *juar* registered a further decline. Compared to 843,000 acres in 1934-35, the area in 1935-36 was 821,000 acres. Due to failure of rains, the *rabi* season was not good. One hundred and fifty-four types have been isolated from the local varieties. Imported types from Bombay and Madras proved too late and produced practically no seed. A new strain, 908, behaved satisfactorily at Lyallpur. The famous strain, J 8, was again a favourite, and its multiplication on a large scale is contemplated. At the Dry Farming Research Station, Rohtak, fifty lbs. seed-rate, for fodder purposes, was better than forty and sixty

[1] The stage when corn contains 33 to 35 per cent water.

lbs. per acre. Germination and root studies were also made at this station.

CENTRAL PROVINCES AND BERAR. The area under *juar* during the year under review was 4,227,000 acres, representing a decrease of 107,000 acres over the previous year. The estimated yield was 845,000 tons. Eighty-two strains were grown during the year including some American importations. Some of the exotics are remarkably early and are being utilized for hybridization. The new selections, 123-A and E B 1, have again repeated their good performance, while an under-trial strain 33 appeared promising during the season. The improved Ramkel and Saoner *juars* were as popular as before. About 19,000 lbs. of seed of the four improved strains was distributed.

SIND grows nearly five lakhs of acres of *juar* annually. During 1935-36 the estimated area was 433,000 acres, showing a decline of 15,000 acres over the previous season. The season was abnormal, the crop having suffered from borer and smut attack. The total yield obtained during the year was 100,000 tons. In the non-Barrage areas of Upper Sind, the two improved varieties, Red Janapur III and Acho Kartuho I, gave appreciably higher yields than the local variety. In a comparison of four fodder varieties in the Botanical Section at Sakrand, Achi Turi gave the highest yield of fodder, but the experiment was not statistically significant. An acclimatized American fodder *juar*, Honey Sorghum, gave higher yields of both grain and fodder. It has a sweeter fodder than the local varieties. Of the grain varieties, Saoro Kartuho I, Bagadar I and Acho Kartuho I maintained their superiority. Of the two new selections, Deeper III and Acho Kodri 25, the former proved better in yield. Among the improved fodder varieties, Achi Turi, Achi Kartuho Turi 56 and Red Turi are being multiplied for extension. During the season 527 maunds of seed of the improved *juar* were distributed.

In the TRAVANCORE STATE experiments conducted at the Puliyara Farm showed that the Mankumari variety gave the highest yield of grain during the current year, while in the previous season Uppukatty was the best.

Bajra (*Pennisetum typhoideum*) is an important dual purpose crop and occupies annually an area of nearly seventeen million acres. The major *bajra*-growing provinces in order of importance are Bombay, the Punjab, Madras, the United Provinces and the Hyderabad State.

In BOMBAY the estimated area dropped from 3,946,000 acres in 1934-35 to 3,538,000 acres during the year under review. The estimated yield for the year was 476,000 tons. At Niphad careful in-breeding has brought to light morphological and physiological deficiencies of the *bajra* plant. These studies have necessitated modifications of the breeding technique. The botanical and agronomical studies of the Poona strains 54, 37, and 59 and Akola and Niphad varieties have shown that the latter two are superior to Poona strains due to (1) better field germination, (2) a well-filled earhead, (3) larger size of grain and (4) a much better crop stand. These advantages are brought about, to a certain extent, due to lateness and better plant physique of the Akola and Niphad varieties. Simple and partial correlation studies of the earhead characters have shown that it is desirable to select long and medium dense panicles. Yield trials of the African *bajri* with the Niphad local have definitely proved the superiority of the latter under dry conditions. The former is being utilized in hybridization to improve the length of panicles of local varieties. At Nadiad, in Gujarat, a number of strains have been isolated and are under trial.

The PUNJAB grew 3,018,000 acres of *bajra* during the 1935-36 season. This represents a decrease of 25,000 acres over the last season. The total yield of grain for the year was 390,000 tons. Mass selection is being utilized to improve the crop and some early cultures have been obtained. By the pedigree method three strains have been evolved which have given much higher yields than the local for two years. An extremely early type from Bikaner proved a poor yielder. The African *bajri* introduced from Jamnagar, was very late and did not yield much over the local variety. The strain A1/3 continued to give higher yields in the districts of Hissar, Rohtak, Gurdaspur and Rawalpindi. The bristled type 61/21 outyielded the local varieties in Sirsa, Rohtak, Gurgaon,

Rawalpindi, Jhelum, Gujranwala and Ferozepore. Seed-multiplication of the strains on a large scale is contemplated.

At the Dry Farming Station, Rohtak, selection of *bajra* has been undertaken. Interculturing with the Kasola hoe gave about 100 lbs. more yield per acre than the control. The eight lbs. seed-rate per acre proved better than six and ten lbs.

The area under *bajra* in MADRAS during the year was 2,712,000 acres, showing an increase of 115,000 acres over the previous season. The total yield obtained during the season was 716,000 tons. At the Millets Breeding Station, Coimbatore, P T 504 and M S (P T) 1546 strains gave twenty-five per cent increase in yield over the standard. The irrigated strain, M S (P T) 2229 and the rain-fed strain P T 248 are being multiplied for distribution. Selection from a Punjab variety has been taken up and the African variety from Jamnagar is also being tried. A detailed study of the tillering habit of *bajra* under rain-fed and irrigated conditions has been made.

During the year under review, HYDERABAD had 2,198,000 acres under *bajra*, an increase of 86,000 acres more than during 1934-35. The estimated yield for the year was 133,000 tons. The Cawnpore bristled variety has been found suitable in the eastern districts of the State. The Akola variety from Bombay and a variety from Bihar are also promising.

CENTRAL PROVINCES. The area under *bajra* during the year declined by 4,000 acres, showing a total of 89,000 acres. The total yield for the year was 18,000 tons. Out of the eight bulk strains grown, five have given good yields. For purification purposes, 132 single lines of different strains were grown.

In SIND the area during the year was 755,000 acres and yielded 89,000 tons of grain. Most of the area is concentrated in the Thar Parkar district. In a trial consisting of six varieties, Sujawal, a long panicled variety, gave significantly higher yields. The Poona strains, 54, 37 and 59 were no better than the local. The African variety introduced from Jamnagar proved too late and was a mixture of many forms.

In RAJPUTANA, A 1/3, an awned type from the Punjab, gave significantly higher yields than the local at three places in Alwar

State and at two centres in Khetri. At Mandore, in Jodhpur State, A 1/3 was no better than the local, while at Basi, in the Jaipur State the local was better. The Punjab types may suit also Barwani State. The African variety is also being compared at various places. Both the African and A 1/3 did not ripen uniformly. Three types breeding true have been isolated in Bihar and Orissa.

Ragi (*Eleusine coracana*) occupies annually an area of nearly seven million acres. Of this, Madras and the Mysore State possess nearly one-third each : the rest being taken up by Bombay, Bihar and Orissa and the Hyderabad State.

In MADRAS extensive work is being done at the Millets Breeding Station, Coimbatore. The famous strain, E C 593, continued to be popular. When compared with T 8, H 22 and locals, E C 593 was significantly better in the III circle. In the V circle[1] also it gave increased yields to the extent of fifteen per cent. A new early strain, E C 1507, has been released for trial in the Chingleput and South Arcot districts. The mutant strain, E C 3030, from E C 593, appears promising as an early variety. The best sowing time in the main season for the 3½ months strain, E C 1000, was June and for the summer season, January to April sowings were equally good. For E C 24, a 4½ months crop, June and July were equally good for the main season, and January to April for the summer. During the season, 8,095 lbs. of seed were distributed in the Presidency. Over, 10,000 acres are under improved strains of *ragi*.

Fortnightly plantings at Hagari showed that the two Anakapalle strains, 355 and 525, do well if planted by the 15th of May and that the sowing of E C 593 by the 15th of July helps it to give better yields. At Koilpatti E C 593 gave a fifty-five per cent increase in yield over the local, but its open panicle is disliked by the cultivators. A type, E C 24, from the Millets Specialist, gave also very high yields. At Anakapalle No. 525 appears to be promising to the southern talukas of Vizagapatam district.

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[1] Comprises the districts of Trichinopoly and Tanjore.

In MYSORE the improved strain H 22 continued to spread. Over 20,000 seers of seed of improved *ragi* strains were distributed. Over a lakh of acres are estimated to be under improved strains. Three diseases are under study and various preventive methods through seed are under trial. At the Kar Ragi Station, Hunsur, seventeen selections have been obtained out of eighty-six.

In the BOMBAY PRESIDENCY the four improved strains A-18, B-11, E-31 and E-82 continued to spread. In Devgad and Rajapur talukas of the Ratnagiri district 4,000 lbs. of seed was distributed to Taluka Development Associations. The Hatkhamba sub-station is also multiplying seed for general distribution.

Other millets.—Among the other millets, *Setaria italica*, the Italian millet, is the most important. Considerable work is being done at COIMBATORE. During the year eleven rain-fed types have been retained for comparison with the standard strain, S I 523. Selections from a cross are also being made. Selection work is also being done at the Dry Farming Sub-station, Hagari. Comparative trials with a number of strains have given conflicting results with those of last year. Detailed studies of root-system are being made at Hagari. Two broad groups have been met with ; (1) deep rooted and (2) shallow-rooted varieties. In the former the varieties have many short culms with small compact panicles, while the latter is associated with varieties with a few tall tillers and semi-compact or loose panicles.

At the Dry Farming Sub-station, Raichur, in HYDERABAD, six strains from the Millets Specialist, Madras, were compared with the local. Although the experiment did not show significant differences, the strains S E 523 and K 92 appear promising.

In the BOMBAY PRESIDENCY improvement of the Italian millet is being done at Niphad.

15. Other Cereals

Barley. A little over six million acres were reported to be grown under barley, of which the United Provinces, Bihar and Orissa and the Punjab, combined with their 3·75, 1·25 and 0·66 million acres respectively, contributed about ninety-four per cent.

Investigations were started into the malting and brewing qualities of Indian barleys under the scheme sanctioned by the Imperial Council of Agricultural Research in 1934, and results of the first instalment of barley samples supplied to the Institute of Brewing, London, from the United Provinces, Bihar and Orissa and the Punjab were received in the year under report.

In the case of the UNITED PROVINCES samples, eighteen in number, the Barley Valuation Committee of the Institute, after examining the barleys and malt therefrom commented that No. 251 Cawnpore had the most finished and best appearance. It was reported to be a very good barley, very suitable for brewing. It malted easily, gave a useful type of malt, which it was expected would give exceptionally high extract. However, it was considered that its thin skin and husk would not provide adequate mash-tun drainage material which would detract from its utility. Nos. 255 and 259 from Cawnpore and 251 from Kalianpur were also of good appearance and suitable for brewing but not quite of the quality of No. 251 from Cawnpore, while No. 251 both from Bahraich and Fyzabad and Pusa 21 from Cawnpore were considered of rather low grade. About No. 253 from Cawnpore, the opinion was that it is not worth shipping as brewing material. It will be seen that barley 251 from the United Provinces appears to have found favour with the Valuation Committee, especially on account of its bright colour. The cultivation of this type is now being encouraged in the United Provinces by a subsidy to growers from a Government grant.

In the case of BIHAR AND ORISSA samples, forty in number and sent in two sets of twenty each by two different routes, *viâ* Karachi and *viâ* Calcutta, it was noticed that those shipped by the shorter sea route, *i.e.*, *viâ* Karachi, contained 1·5 per cent more moisture than those sent through the longer route, *i.e.*, *viâ* Calcutta. It was further found that barleys grown in South Bihar were distinctly superior from the brewer's point of view to those grown in North Bihar. For example, barley type Pusa 21 grown at Pusa and Sepaya (both in North Bihar) showed up poorly, whereas the same barley grown at Sabour and Patna (both in South Bihar) was highly praised.

This definitely shows that climatic and edaphic factors play a very important part in the quality of this crop.

In the case of the PUNJAB samples, six in number and belonging to six different types, the appearance was not considered to be very favourable. But they gave better results than what was anticipated from their appearance. The manner of their working during malting, and the appearance and analysis of malts proved that they were good malting material. All the malts were bigger than the barleys and they had improved considerably in appearance during malting. Extracts obtained from them were higher than what was expected from their appearance. These remarks applied with particular force to type 4 which is on the approved list of the Punjab Department of Agriculture and is extensively grown in the Gurgaon district, the produce of which is in great demand and is held in high esteem by breweries all over India.

Yield trials repeated for the third time at the KARNAL BOTANICAL SUB-STATION showed that Pusa 13 is particularly suitable for Karnal conditions and that therefore it is likely to do well in tracts with similar conditions of soil and climate. In trials of late to very late sowings of *rabi* cereals in the Punjab at Hansi, Punjab barley type 4 yielded considerably better than any type of wheat tested. At Rawalpindi, Punjab type 5 gave the best yield, while at Lyallpur, Punjab type 5 and Pusa type 21 yielded equally well.

Natural crossing in barley. This was under observation at Lyallpur and repeated work has shown that at Lyallpur barleys are liable to more frequent and extensive natural crossing than wheat, a finding quite the reverse of what is stated to be the case in Europe and America.

Oats. A number of promising plants have been selected from the F_2 generation of a cross made at PUSA between Orion, a late-maturing Swedish variety which but for its lateness would be an ideal variety for green fodder in Northern India, and Pusa hybrid J. In the PUNJAB both the early and late maturing varieties were under investigation. Among the early types, Weston and Pusa hybrid J gave the highest yields and among the late ones F O S 1/29 stood at the top. In the group of trials with the French,

Algerian and F O S 1/29 oats, the last two, which are narrow-leaved, gave the highest yield of green fodder at every agricultural station where tried. They also gave the highest yield of seed.

Maize. A little less than seven million acres were reported to be under maize, of which the United Provinces, Bihar and Orissa and the Punjab, combined with their 2·1, 1·7 and 1·1 million acres respectively, contributed about seventy per cent.

Some forty-four cultures, selected for either yield of grain or for fodder or for both, together with in-bred strains and hybrids thereof, were grown at PUSA, selfed ears from which revealed a large variety of endosperm and aleurone colours. The in-bred strains were further in-bred and, for the purpose of ascertaining good combinations, direct and reciprocal crosses were made between all the different strains. Two mutant types, one liguleless and the other with salmon-coloured silks, were found in a field of maize grown for fodder. In the PUNJAB none of the twenty-six imported foreign types gave good yields, but the local variety White 1 has established its superiority in different parts of the Province. The technique evolved of avoiding cross-pollination in maize by surrounding each variety with a 15-feet wide border of Elephant Grass is working successfully. In the UNITED PROVINCES selections Nos. 10, 13 and 41 have given satisfactory yields.

16. Potatoes

POTATO-BREEDING was carried on mainly at the Potato-Breeding Sub-station, Simla and at the Agricultural Research Station, Nanjanad. Both these potato-breeding schemes are financed by the Imperial Council of Agricultural Research.

The work at Simla is linked with that being conducted by the Botanical Section of the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE and its object is to breed varieties of potatoes suitable for North Indian conditions. During the summer of 1935, co-operative trials were conducted at Simla, the Murree Hills and the Kulu Valley in the Punjab, at Chaubattia and Khabrar in the United Provinces, and at Shillong in Assam, to determine the most suitable site for a potato-breeding sub-station in the hills. Out of these stations

Simla was selected, because flowering and berry formation here were satisfactory and other facilities were also available.

During the year under report a large amount of material, consisting of samples obtained from different parts of India, was studied. A large number of seedlings were also raised from true seed of the Pusa Local and Coonoor White varieties and were under study.

In addition, a considerable amount of material of the South American and Central American species, and hybrids between these and *S. tuberosum*, received through the courtesy of workers in Russia, America, Germany and England, was grown. As soon as this has been multiplied, it will be tested for resistance to disease, etc.

A detailed study was made of flowering, pollen fertility and berry production. Most of the cultures flowered at Simla, and some formed berries freely. Crosses were made between commercial varieties and *S. andigenum*, *S. demissum* and *S. neoantipoviczii*, three species known to possess characters of value for breeding.

At PUSA, experiments were in progress to study the effect of several physical and chemical treatments upon the dormancy of potato tubers. Some potato-storage tests were also carried out with the co-operation of the Cold Storage Research Station at Kirkee.

At NANJANAD, work was in progress with the object of evolving, from true seed, new varieties which would be more suitable for Indian conditions than imported varieties. The characters which are being specially kept in view include early maturity, resistance to disease, drought and frost, and good keeping quality. During the year under report a large number of crosses were attempted, some of which proved successful. A large number of seedlings were grown, and the raising of seedlings was more successful than in the preceding year.

Ten new varieties were imported from Russia, but out of these only two survived. Material of *S. neoantipoviczii* was multiplied.

Experiments to force flower production in varieties that normally drop their flower-buds before the latter open were unsuccessful. The treatments tried included (1) removing of tubers as soon as

formed, (2) constricting the top internodes of haulms with thin copper wire, (3) supplying different nutrient solutions to the plants.

A beginning was made in the study of virus diseases.

Varietal trials were also carried out. Among the main crop and second early varieties, Ben Cruachan and Great Scot respectively were the best.

The MADRAS Department of Agriculture carried out experiments to investigate the influence of the size of seed and spacing on yield. Experiments on deep *versus* shallow ridging for the second crop and experiments on keeping quality and the time of irrigation in relation to planting, were also in progress. Manurial experiments were continued.

66,012 lbs. of seed was distributed during the year. In BENGAL potato demonstrations were carried out on cultivators' lands using the varieties, Nainital, Darjeeling, Up-to-date, Majestic and *Desi*. To encourage the cultivation of better types of potatoes, arrangements were made for the supply of good seed.

Considerable attention continued to be paid to mosaic disease in the UNITED PROVINCES as it is recognised that this disease is an important agent in the deterioration of potatoes grown in the plains. Varietal trials were also carried out. The variety Phulwa gave the best yield, but Katie Glover produced the best quality tubers and was also three weeks earlier in harvesting. The results of the trials indicate that seed potatoes of some hill and foreign varieties, raised from an early summer crop in the hill districts and stored in the hills during the monsoon, do very well in the plains when planted as an autumn crop and are profitable to grow.

Variety trials were also carried out in the PUNJAB by the Punjab Department of Agriculture, Up-to-date, President and Windsor Castle being considered the most promising varieties. The Department is making a serious attempt to render the Punjab self-sufficient in the matter of supply of seed tubers for the autumn crop by arranging for such a supply from the Kulu and Kangra valleys.

Of the varieties tested in BIHAR, namely Darjeeling Red Round, Darjeeling White and Patna, the last-named gave the highest outturn.

In ASSAM extensive variety trials were carried out. In these, the variety Majestic gave the best yields. It is concluded from the results which have been obtained that new imported varieties give higher yields in their first two or three years and then drop to the level of varieties imported eight or ten years back.

The manurial experiments were continued. The effect of the addition of potash was notable, but the results require another two years' work for confirmation. An experiment on vernalization was also carried out successfully, the crop from the vernalized tubers giving an increase of sixty-four per cent in the weight of tubers harvested.

Italian varieties are mostly grown in SIND. The Department is paying special attention to the problems connected with seed supply and to the manurial requirements of the crop under Sind conditions.

17 Beans and Pulses

Gram (*Cicer arietinum* L.), which is one of the most important of the pulses in India, occupied 16,881,000 acres in 1935-36 and the total estimated yield was 3,899,000 tons ; the area and yield in the principal gram-growing provinces and States being as follows :—

	Acres	Yield (tons)
United Provinces	5,680,000	1,718,000
Punjab	4,708,000	954,000
Bihar and Orissa	1,348,000	383,000
Hyderabad	1,272,000	207,000
Central Provinces and Berar	1,217,000	231,000
Mysore	846,000	81,000
Bombay	650,000	112,000
Sind	313,000	41,000
Burma	274,000	55,000
North-West Frontier Province	223,000	32,000

The area under improved types, so far as figures are available, was 3,32,425 acres.

At the BOTANICAL SUB-STATION, KARNAL, a study of the inheritance of characters in gram was continued and a number of crosses were under observation. A yield trial for the third year with Pusa types 17, 25, 48, 58, 67 and a local variety showed that, under the conditions of the experiment, Type 17 was inferior to the other Pusa types ; the differences among the other types were not statistically significant. About 580 lbs. of improved varieties of gram (T 58, T 25 and T 28) were distributed during the year. In the UNITED PROVINCES, 152,200 acres are reported to be under improved departmental types. The total quantity of improved seeds distributed during the year was 20,815 maunds. In the PUNJAB the Department has under trial a number of Indian and foreign varieties of gram. A study of the root-system of certain promising types (Types 1, 7 and 17) has revealed marked differences in the depth of roots and the number of nodules of the three types examined. Three types (Nos. 7, 15 and 17) have given better yields than the local variety. Experiments have indicated the possibility of increasing the yield of Kabuli gram Type I by increasing the seed-rate. There was a growing demand for improved departmental types of gram and 800 lbs. were distributed during the year. In BIHAR AND ORISSA the area under improved types (Sabour 4 and Pusa 17) was 5,246 acres. A number of true-breeding types are under systematic observation by the Economic Botanist with a view to their final classification. In the CENTRAL PROVINCES AND BERAR the classification of local types of gram was nearly completed. About fifty types have been isolated and will be tested for yield. Of the selected strains under yield trials, type No. 352 is reported to be free from wilt and to give the highest outturn. Another type (No. 62) was also found to be promising. Work is in progress on hybrids previously isolated, and new crosses have been made between Malida gram, which has a very attractive grain and is in great demand in the north of the province, and type No. 28 and Cawnpore grams. In BOMBAY the Crop Botanist continued his work on gram. Three yellow types and one brown-grained type, all early, were found promising in preliminary trials and further work was in progress. A study of flowering in early and late types

was completed. Early types were found to be higher yielding, setting nearly fifty per cent pods as against thirty per cent in the late types. In BENGAL the Second Economic Botanist continued his work on pulses and Type P 58 and Sabour 4 were the best among those tried.

Pigeon-pea (*Cajanus indicus* Spreng). At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, PUSA, the study of inheritance of characters in this crop was continued in a cross T 80×T 66. The inheritance of colour in leaf-vein, flower and pod was found to be on a monogenic basis, while the segregation for seed-colour appeared to depend on the interaction of the first three factors and to be quite independent of those for the other characters studied. That the attack of *Fusarium* wilt on a susceptible type of pigeon-pea was retarded by the toxic effects of tobacco stumps buried in the soil was again confirmed by the results obtained during the year. Seed of the more promising wilt-resistant hybrids (T 80×T 5) was multiplied for yield trials. In BOMBAY classification of local *tur* types was in progress. In BENGAL six types of a selection from Comilla *arhar* were multiplied at the Dacca Farm. The Pusa types and Comilla selections are reported to have suffered from wilt, though wilt is uncommon in this province. The incidence of wilt is being studied. In the UNITED PROVINCES four strains of *arhar* (Nos. 4, 17, 23 and 51) were found promising and these will be multiplied for distribution. In BURMA the Economic Botanist continued his work on this crop. Two varieties of *Pesinngon* (New Era and C-10) proved successful. The former is reported to cover more than 16,000 acres in Thayetmyo district, while the latter about 50,000 in some five districts. The Pusa variety No. 34, which seemed likely to become popular on account of its light-coloured seed, fell into disfavour because of its poor yield. Selection work on early types of *pesinngon* has been started at the Mahlaing Farm, in view of the importance of such types in the dry zones of Burma. In BIHAR AND ORISSA the Economic Botanist completed a systematic study of six Sabour *rahar* types (2 e, 4 e, 7 e, 12 e, 7 s and 10 s). Several other late and early varieties were under observation. In the CENTRAL PROVINCES the

demand for the departmental selection Tur 3 was on the increase both in and outside the province. Seeds of another departmental selection (No. 38), which is wilt-resistant, were distributed to those parts of Berar where wilt was severe. In SIND four varieties of *tur* (Red Tur Hyderabad Sind, Red Tur Digri, White Tur Hyderabad Sind and White Tur Digri) were under study.

Peas (*Pisum sativum* L. and *P. arvense* L.). At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, PUSA, an yield trial was laid out with two types of *P. arvense* and three of *P. sativum*. The differences between the yields of any two varieties were not, however, statistically significant. In BIHAR AND ORISSA all the fifteen varieties of Sabour peas (*P. sativum* L.) (*matar*) were found to be breeding true and a taxonomic study of these was completed.

Lentils (*Ervum lens* L.). At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, PUSA, yield trial of six hybrid lentils against two high-yielding types was conducted. In BENGAL the Departmental selections, D 5 and D 7, were the most promising.

Urid and mung (*Phaseolus mungo* L. var. *Roxburghii* and *Phaseolus radiatus* L.). At the IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, PUSA, a study of the inheritance of certain characters in a cross between a green-seeded (No. 18) and yellow-seeded (No. 36) strain of Pusa *mung* was completed and the results prepared for publication. Yield trials with promising strains of *mung* and *urid* were in progress. In BENGAL breeding work was carried out with the *mash kalai* types.—*P. mungo*, *P. radiatus* and *P. ricciardianus* and interspecific crosses between the table *kalai* and fodder *kalai* were being made. In the UNITED PROVINCES progress was made with the breeding work on *mung* and *urid*. Four strains of *mung* (*P. radiatus*) and three of *urid* (*P. mungo*) have been found promising. In BIHAR AND ORISSA a systematic description of ten Sabour types of *kalai* (*P. mungo* var *Roxburghii* Prain) was completed. Besides two samples of *kalai* from Sepaya and Nawada and two Orissan *kalai biri* were under trial. Study was also made of ten varieties of Sabour *mung* (*P. radiatus* L.). Selection work with the Orissan *mungs* was in progress at the Experimental

Farm at Cuttack. In the CENTRAL PROVINCES forty-six types of *mung* and twenty-six of *urid* were isolated. Among *mung* types Nos. 4, 178 and 179 were promising as regards colour of seed, yield and early maturity and among *urids* types Nos. 42, 110 and 126 were heavy yielders. A description of the morphological characters of all the types were under preparation. In SIND six selected varieties of *mung* were under study.

Beans (*Phaseolus lunatus* L.). In BURMA the Economic Botanist continued his work on butter-beans. Both the old and new selections of Moki Lima (27-30 and 32-40) were multiplied. The latter, being a higher yielder than the former, will be multiplied for distribution. Twenty-four lines of F_8 cultures of Moki Lima $\times$ *Pegya* and Moki Lima $\times$ Pebyugale hybrids were grown. A yield trial with three varieties, Moki Lima 27-30, 32-40 and Pole Lima 32-24, failed to show significant differences. About 6,056 acres are now under improved varieties of bean in Burma.

CHAPTER III

RESEARCH IN CROP PRODUCTION*

1. Soils and Fertilizers

RESEARCH work on soils and fertilizers during the period under review continued on lines similar to those in previous years, and included the study of physical, chemical and biological characteristics of the soil in relation to normal crop-production. The review is confined only to a description of broad outlines of work, the more detailed information being available in the annual reports of the Imperial Agricultural Research Institute and of the research institutions of the various Provinces and States.

Soils

(*a*) ***Soil-surveys.*** A study of two soil-profiles along with an investigation into the clay-complex from the site of the Imperial Agricultural Research Institute, New Delhi, was carried out. A layer of lime nodules occurred from four feet to fifteen feet down, lime being present both as carbonate and silicate. The content of magnesia and potash was constant at all depths, while that of phosphate and silica was higher in the upper layers.

Survey of rice soils in the Central Provinces indicated that these soils were grouped as a climatic type having some important characteristics in common, although they were developed from different rocks.

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In Bijapur (Bombay Presidency) dry tract, three types of soil are met with, namely, (1) the deep black, (2) medium black and (3) the limy soils. The upper four layers (five feet) of the deep black soil showed great similarity in composition, which could, however, be traced only in the two upper layers of medium black and limy soils. Further, the surface layers of deep black soils were richer in potash and phosphate and those of the other two soils richer in nitrogen and phosphate.

In Sholapur (Bombay Presidency) dry tract, the soils are comparatively shallow, mixed with pieces of disintegrated rock, locally known as *murum*. The deficiency of phosphate in these soils could not be found in the parental rock.

On surveying twenty-eight soil-profiles of cane-growing zone of Pravara right bank canal (Bombay-Deccan), they were classified into various types according to their profile characteristics. The shallow types were characterised by low calcium carbonate and humus. There was a great variation in phosphate and potash from type to type, although they were not dissimilar in nitrogen-content. A wide range of variation in the ratios of SiO_2/Al_2O_3 and SiO_2/R_2O_3 was noticed in the parental rock of these soils.

The profile study of *chopan* soil, a typical alkali soil, showed that it resembled certain other degraded types of the same locality with accumulation of silicates, general low values for base-saturation capacity and the presence of high exchangeable sodium.

An extensive study of soil-profi lesconducted in Tungabhadra project, in the Madras Presidency, revealed that the majority of soils were deep black soils having a high water-holding capacity and high base-exchange capacity.

During a study of soil-profiles in the dry tracts of Hagari (Madras), grey granite was found to be the predominating rock.

In the Punjab, a soil-survey of the saline lands south of the salt range in the Pind Dadan Khan Tahsil was carried out. The salt was found to be carried by the perennial salt-laden streams and also by those during the rainy season. The salt streams do not directly reach the lands but sink into the sub-soil at the foot of the hills, and from this sub-soil reach the surface.

A study of the soil-profiles at Rohtak shows that sub-soil varies from fine sand to a stiff clay soil and is impregnated with *kankar* concretions.

In Bengal, Bogra soils predominate in fine sand and silt fractions, while coarse sand is almost absent. The presence of gravel in fair proportions and coarse sand in Birbhum soils admits of free percolation.

(b) Base-exchange and related soil properties. At Dacca a number of physical constants have been determined with a view to find out if these can be utilised in characterising soils. In general, a broad relationship between the clay-content and most of the constants is observed, but the presence of organic matter obscures any closer relationship.

At Lyallpur the effect of various cations saturating the soil on some physical and physico-chemical properties was studied. The nature and amount of cation greatly affects the dispersion co-efficient, water-holding capacity, the rate of percolation and *p*H. The effect of various ions saturating the soil on plant-growth was also investigated. Sodium and ammonium saturated soils do not support plant-growth, but soil saturated with calcium, magnesuim, manganese and potassium can do so.

At Lahore, the effect of about fifteen different ions on plant-growth, seed-germination and in some cases on full growth in the fields was investigated. Salts of uranium, thorium, cerium, manganese and zinc accelerate growth even in concentrations of the order of 1×10^{-7} mols.

The electro-chemical behaviour of silicic acid and clay acid soils was studied under a variety of conditions in Calcutta.

At Dacca, base-exchange measurements of electro-dialysed clay by titration with baryta and caustic soda were carried out both potentiometrically and conductometrically up to definite *p*H values. Soil colloids were found to absorb bases continuously with increasing *p*H.

At Raipur (Central Provinces), the application of sulphate of ammonia or phosphatic manures tended to remove calcium from the exchangeable complex of the rice soils. The *p*H value was

found to increase with depth and an optimum *p*H range of 6·0 to 7·0 gave reasonably high yields for the finer types of paddy.

At Hagari it was found that *p*H values obtained by hydrogen and quinhydrone electrodes agreed within a range of $\pm 0{\cdot}2$.

In the cane-growing zone of Bombay-Deccan, quite contrasting values of exchangeable sodium were found between one soil-type and another. Soils could be found highly saturated with exchangeable sodium, becoming impervious to water and offering considerable resistance to the plough.

At Hagari, methods for determining the total colloids, both organic and inorganic, were tested. For heavy soils the hydrometer method was unsuitable due to inadequacy of dispersion, whereas for the light soils both the methods of absorption and hydrometer fairly agree.

A comparison of the methods for mechanical analysis of soil indicated better dispersion by Puri's method than by the International method.

At Pusa three methods of pre-treatment, *e.g.*, (1) boiling, (2) sodium chloride and (3) the International method were applied for the mechanical analysis of Delhi soils. The last two methods gave increase of clay fractions with a corresponding reduction in the coarse fractions.

At Dacca, the alkaline permanganate method developed for the mechanical analysis of laterite soils has been found suitable for gypseous soils.

At Calcutta, sodium ferrocyanide has been found to be a good dispersing agent for some Bengal soils, and its suitability for characterising laterite soils is being studied.

(c) *Soil and irrigation.* In Bengal, the work on the evaluation of the Damodar canal silt has been brought to conclusion. The maximum benefit of the fertilizing silt is obtained within one-fourth of a mile; the deposit, however, extends not much beyond three-fourths of a mile.

At Dacca, in spite of shortage and uneven distribution of rainfall, the average yield of plots in one area was increased by fifty per cent by extra irrigation.

Badarkhali island in Chittagong shows indications of barrenness due to accumulation of salts resulting from insufficient drainage.

In the United Provinces it has been observed that there is a progressive increase in the yield of sugarcane with corresponding increase in the number of irrigations.

In the Punjab it is suggested that the alkalinisation of the saline lands south of the salt range in the Pind Dadan Khan Tahsil can be checked by the presence of a large amount of calcium and a wholesome irrigation in sufficient quantity.

Reclamation of *kalar* soil by calcium is in progress at the Montgomery farm. Gypsum has been found to be economical due to its cheapness. The cultivation of rice and berseem on *bari*-type soil during *kharif* and *rabi* respectively shows the possibility of improving the soil without calcium. A heavy leaching dose of irrigation is effective in improving most *kalar* soils. But the salts so leached down have a tendency to return to the surface.

In Sind, certain systems of rotation and green-manuring are being tested to avoid and minimise the reversion of the reclaimed areas. The results so far obtained indicate that *guar*-wheat-cotton and *ragi*-wheat-cotton are two suitable systems of rotation and green-manuring with *guar* has been helpful in maintaining the area already reclaimed in good condition.

The reclamation of *chopan* soil in Bombay-Deccan was tried with applications of sulphur, gypsum and farmyard manure in various combinations in June, followed by irrigation and drainage. The treatment brought about a considerable loss of exchangeable sodium and in total base-saturation capacity of the soil. A crop rotation of cane-cotton-berseem was found to reduce sodium saturation in these soils.

The percentage run-off increased considerably in Bijapur soils over the previous year. Apart from the loss of rain water, the loss of lime and silt, which are the predominant constituents of run-off, threatened deterioration due to the formation of sodium clay. Weed-cover on these soils was found to be an effective preventive of run-off.

Bunds at Hagari were sufficient to prevent leaching. Plots bunded gave 30-37 per cent higher yields of sorghum than unbunded plots.

In the cane-growing area of Bombay-Deccan, the effect of irrigation on the profile of a particular soil-type was found to result in a change of *p*H value of the surface, the decrease of total salt-content in the second and third horizon and again in humus in the first and third horizon.

Ground water in both medium-deep and *chopan* soils showed an appreciable amount of salinity with a considerable washing out of organic matter. But the sesquioxides were hardly leached. Comparing the ratios of bases in soil and ground water, the relative leaching out of sodium was far greater than calcium in *chopan* soil with a comparatively small loss of magnesium. The soil leachings were found to have a far reaching effect in modifying the structure of these soils. A gradual lowering of the sub-soil water-table was noticed in both medium-deep and *chopan* soils year after year.

(d) Soil moisture. The concentration and distribution of moisture in relation to plant, season and manurial treatment were studied at Hagari. Preliminary experiments were started to study the effect of soluble salts on the evaporation of water from the soil-surface. In glazed pots containing twenty per cent moisture, the salts were applied as a soil mulch. Highest amount of water saved was 11·26 per cent by calcium nitrate and potassium sulphate.

The deep and medium-deep soils of Sholapur exhibited higher values of moisture equivalent than the shallow types. Bijapur soils showed a gradual decrease in moisture equivalent to the increase of lime-content. In these soils penetration was very much influenced by the intensity, duration and quantity of rain. These soils lost their moisture very soon, the wilting coefficient being reached even at the beginning of December, when the crop needed moisture most.

At Pusa, it was found that the moisture equivalent of an acid Assam soil decreases with the decrease in soil acidity (2/3 application

of lime requirement) and then begins to increase with increasing lime-treatment.

In Bengal, while studying the evaporation of soil-moisture under field conditions, it has been found that there is an equilibrium moisture zone beyond twenty-one inches where the moisture-content of the soil does not vary much during the dry season. The moisture-content of this zone is about twenty-three per cent.

The loss of combined water between 250°-600°C. varies inversely with the composition of clay, being larger for lateritic soils of low SiO_2/R_2O_3 ratio. The combined water when calculated for 100 gms. of clay gives a figure which indicates the presence of free sesquioxide and therefore may be utilised for characterising lateritic soils.

At Rohtak (Punjab), conservation of soil-moisture under different conditions of cultivation was studied with two light and heavy types of soil. The intercultivation of crops does help in the conservation of soil-moisture, and the loss of moisture from stirred plots is less than from the unstirred.

(*e*) ***Soil microbiology.*** In the rice soils of Raipur, the maximum activity of the micro-organisms like *Azotobacter* and *Bacillus radicicola* was found with the production of ammonia within a *p*H range of 6·0-7·0. In a comparative study of the decomposition of farmyard manure and ammonium sulphate in these soils under water-logged conditions, attention was mainly focussed on the bacterial numbers and bacterial activity.

In Madras, studies into the nature and activity of sulphur-oxidising organisms led to the conclusion that for maximum sulphur oxidation it was necessary to supply an adequate quantity of nitrogen in the form of ammonium sulphate or urea and carbon in the form of sodium carbonate.

In the cane area of Bombay-Deccan, it was found that the bacterial number in soils with higher carbon-nitrogen ratios showed a rise three days after moistening, and then there was a fall, taking a fortnight to come to a minimum.

In the Punjab, other bacteria have been found to influence the nitrifying bacteria in manure pits. The difficulty of obtaining

a pure culture of Nitrosomonas seems to be solved by carbon dioxide treatment which reduces the number of contaminants. It was further noticed that greater benefits would be derived by applying molasses to the heaps of soil than directly to the field, the decomposition being much quicker in the heaps.

At Dacca, the nitrogen-fixing green organism isolated from Faridpur soils could not be obtained in the pure state. A white growth entirely different from the green one was obtained by inoculating the green organisms into a medium containing carbohydrate, in the presence of which white organisms can fix nitrogen.

The number of bacteria decreased on storing Pusa soils from 1906, while the fungi increased. Spore-forming organisms alone survived, while the activity of urea-splitting and ammonifying organisms did not diminish. The carbon-dioxide-forming capacity remained unaffected. Nitrifying organisms completely disappeared or became inactive.

(f) Soil nitrogen and nitrification. The soils of Bijapur and Sholapur were found to be low in nitrogen-content.

In the cane-growing zone of Bombay-Deccan there was a gradual fall in the nitrate-content irrespective of manured or unmanured conditions. The periodical fluctuations were found to be high immediately after planting, and during the later stages of plant-growth, the soil-nitrate was much reduced.

Nitrogen recuperation in various soils of Bombay was found to follow the usual cycle of fluctuations. The highest total nitrogen was found in the cold season, the lowest being in the middle of the rains and the hot season.

Field experiments showed that the cropped rice plots contain more nitrogen than the uncropped ones during the growing period of rice. It was concluded by laboratory tests that rice soils have the power of fixing nitrogen, and that this is helped by the paddy roots.

At Dacca, previous determinations on the fixation of nitrogen in water-logged soils and exposed to the sun have been confirmed on a number of rice soils from different parts of India. Nitrogen fixation is slightly greater in faintly alkaline soils and hence the

advisability of adding lime to soils of lower *p*H is under consideration.

At Shahjahanpur and Muzaffarnagar (United Provinces), it has been observed that the amount of nitrogen added to the soil in the form of *sanai* is the largest in the case of fifty days' growth, followed by sixty, forty and thirty days' growth. The conservation of nitrogen is greatest in the plots receiving additions of 270 maunds of molasses followed by those of 180, 90 and control. De-nitrification sets in after a month of incorporation, and after a constant level of three to four months, it comes back to that contained in the no-manure plot.

At Pusa, the relative merits of calcium carbonate and sodium carbonate individually and in combination as correctives of soil acidity were studied and the last named was found to increase nitrification. The addition of phosphate did not increase the total nitrate formed, but increased the rate of nitrification.

The application of sunlight and of ultra-violet light from a mercury-vapour lamp on acid and alkaline soils using different nitrogenous substances did not give any evidence of photo-nitrification, but rather inhibited nitrification and reduced nitrates.

(*g*) ***Soil organic matter.***—At Dacca, Tiurin's method of estimating soil organic matter by its oxidation with potassium dichromate, sulphuric acid mixture and subsequent titration with 0·2 normal ferrous ammonium sulphate was found to be rapid and accurate with only a slight modification, the titre strength being changed to 0·1 normal.

At Raipur (Central Provinces), of the two methods compared for estimating soil organic carbon, Schollenberger's method as modified by Allison was found to be more advantageous and rapid than the wet combustion method, being unaffected by carbonates in the sample.

Almost all the rice soils of the Central Provinces were poor in humus in spite of moderate application of organic manures. Humus was found to decompose very rapidly, and as such it was inferred that the ligno-protein complex of the soil was comparatively rich in protein.

In the cane-growing area of Bombay-Deccan the application of sulphate of ammonia and farmyard manure to two types of soil having high carbon-nitrogen ratios at higher moisture saturation showed that the nitrification of added ammonium sulphate was not hindered in these soils at low moisture levels and the reaction is independent of farmyard manure.

(*h*) ***Organic manures and composts.***—In the Punjab, a series of experiments both in *kacha* (built of earth) and *pucca* (brick-built) pits were carried out to get the optimum results from farmyard manure. The loss of dry matter and nitrogen is less in deeper *pucca* pits. Double pitting was resorted to, to allow the aerobic fermentation to proceed at a quicker rate in shallow pits during the first month and then to conserve the products in deeper pits. The results are encouraging. There may be a loss in the volume of manure, but the improvement in quality more than balances the loss. It may be that the anaerobically attained conservation does not pay.

At Hagari (Madras Presidency), the effect of green-manuring on soil structure was found to result in yielding a lower amount of clay fraction. At Anakapalle it was found that the quality of sugarcane juice from plot treated with molasses was as good as in any other plot treated with groundnut-cake, farmyard manure, etc.

In the cane-growing area of the Bombay-Deccan, the decomposition of sugarcane trash by direct incorporation with the soil along with ploughing down sann was found not to be beneficial in preventing the leaching of nitrates though it delayed the process a little. The decomposition of the trash was complete within two months and there was a slight increase in humus and nitrogen-content of the soil by this treatment.

In the Central Provinces pot experiments were conducted to find out the effect of various shellac waste materials on the growth of wheat in black cotton soils to dispel the notion of the supposed injurious effect on the crop. In all the treated pots the seed-formation was normal and no injurious effect whatsoever was noticed. On the other hand, there was an increase of forty to one hundred

per cent of yield. But the soil probably requires more nitrogen on account of the added organic matter.

In the Central Provinces the method of preparing synthetic manures from organic materials like *karanja* (*Pongamia glabra*) leaves and paddy-straw in pits under semi-aerobic conditions was tried by using cheap and easily available starter. The total nitrogen-content of the leaf and the straw composts was 1·06 per cent and 0·30 per cent respectively, giving definitely higher yields of paddy.

In the cane-growing area of Bombay-Deccan, the efficiency of a leguminous weed, *Patada-Sherva*, (*Alysicarpus belgaumensis*,) as a manure was successfully tried in medium and heavy soils.

Laboratory tests made in Travancore on the quick decomposition of green manure mixed with nitrogenous and phosphatic fertilizers revealed that the method yielded larger amounts of plant nutrients with consequent greater crop-production.

The addition of organic matter by farmyard manure and sann to the shallow and dry tracts of Bijapur and Sholapur gave higher yields of sorghum.

Compost-manuring was found neither beneficial nor economical to the majority of South Indian tea soils.

In the Punjab, the application of molasses did not give desirable results with sugarcane.

Fertilizers

The need to determine the requisite proportions of phosphate and nitrogen received attention from several experimental stations. At Sabour in Bihar, it was found that the higher doses of phosphate had no action over a fixed dose of nitrogen, whereas the yield had proportionally risen as the dose of nitrogen was increased. But it was pointed out that the combination of phosphate and nitrogen in the ratio of 2 : 3 remained unbalanced and did not yield satisfactory results. At Raipur in the Central Provinces quantitative studies revealed that the ratio 1 : 1 gave the best results.

At Berhampur, it was suggested from several manurial trials that a judicious combination of nitrogenous and phosphatic manures in any form was beneficial to the crop.

The finding of Prof. R. H. Dastur that the supply of nitrogen to the rice plants in the combination of sodium nitrate and ammonium sulphate was more beneficial than supplying them separately was not confirmed by field experiments in the rice research stations. Only in Travancore, on poor laterite soil was the mixture the best treatment.

At Berhampur, the application of super-phosphate gave a higher yield than bone over basic a manure of green leaf. Super-phosphate showed a greater residual effect than bone. Dressing the soil with lime did not give any beneficial effect.

In Burma, the infertile soils of Hmawbi were treated by (1) steaming, (2) subsoil (8-12 inches), (3) finely ground lime, (4) magnesium chloride (5) sodium chloride and (6) potassium chloride; of these the first five gave higher yields of grain and straw.

The residual effect of both nitrogenous and phosphate manures was tried at Sabour in Bihar. Ammonium sulphate and phosphate gave the highest outturn.

A cheap and efficient method of pulverising bones was developed at Travancore by immersing them for about two months in a solution of two per cent common salt and 1·5 per cent caustic soda.

At Raipur in the Central Provinces, bones were disintegrated by alkali in a brick masonry tank, the walls and bottom of which were plastered with cement. The total cost of production amounted to Rs. 2-7-0 per 100 lbs.

In Sind, manurial experiments with different forms of nitrogen with and without super showed that ammonium sulphate applied alone gave the highest yield, and castor-cake had a depressing effect.

At the Nagina Rice Research Station in the United Provinces, different quantities of nitrogen and phosphate, either singly or in combination, have no influence on the crop-yield.

At Tocklai in Assam, the increase of tea crop is proportional to the quantity of nitrogen applied up to eighty lbs. per acre annually. Considering the crop-yield and preservation of tilth, ammonium sulphate stands best among nitrogenous fertilizers due, perhaps, to

its acid reaction. In the early years sodium nitrate did well, but its continuous application spoils the tilth.

From the experiments conducted here, it is apparent that a large dose of soluble artificial manure can be applied at once to restore a bad patch of tea soil without incurring any damage, a high level being maintained by moderate manuring.

Boga modeloa, used as a green manure, showed significantly a positive loss of tea crop.

In Bengal, the effects of potash, magnesium and phosphoric acid were studied on paddy. High yields were obtained with a low dose of potassium sulphate at 2·8 maunds per acre. In high doses potash has a depressing effect. Where phosphate is constant, magnesium has a tendency to increase yield with increasing doses. Similarly, with constant magnesium, phosphate increases the yield proportionally.

At Dacca, amelioration experiments of lateritic soils for the last three years with lime, Niciphos, sulphates of potash and magnesium, singly or in all possible combinations, showed that Niciphos and lime increased the yield of grain this year. The effect of the others was not appreciable.

In Cochin, ammonium sulphate alone has been found to be superior to sodium nitrate or the mixture of the two in increasing the yield of paddy. In the cultivation of sugarcane, oil-cakes have been found to be the most important manure. Growth of paddy in the *chukkan* lands of Chittur taluk is extremely poor, due to excessive lime in the soil. It has been suggested that a mixture of ammonium sulphate and superphosphate solves the problem to a great extent.

In Assam, addition of different doses of cow-dung to soil in Titabar farm gave a proportionately significant increase of Prasadbhog paddy. Cow-dung as a manure for potatoes also shows satisfactory results.

In the Sugarcane Station, Risalewala (Punjab), potassic and phosphatic manures have no effect on yield, whereas significant results are obtained with nitrogenous and complete artificial manures.

The effect of the latter is attributed to the presence of nitrogenous constituent.

At Pusa, the vertical distribution of carbonates and phosphates in calcareous soils and the effect of manuring and cropping on the same were studied. It was found that in borings down to a depth of five feet there were two zones of maximum carbonate concentration with one of minimum concentration lying between the two in all the manured and cropped plots. In the fallow plot carbonate concentration gradually increased with depth. Phosphate concentration tended to vary inversely as the carbonate concentration.

Since high amounts of acid were required to convert Kudada phosphates into super-phosphate, it was found to be an uneconomic proposition to utilise these natural phosphates.

Results of large-scale experiments carried out in the field showed that while the yields of wheat from sann-hemp whole plant *versus* tops alone were the same, the yield of fibre from the stems remaining after using the tops as manure was 500 to 650 lbs per acre.

(*a*) ***Fertilizer practice.***—In all the rice research stations of Madras, Bihar, Orissa and the Central Provinces the comparative merits of manuring the seed-beds and the transplanted plots were tried. It was found that the manured transplanted plots gave higher yields than the manured seed-beds.

The application of ammonium sulphate at the time of planting sugarcane setts was tried. In Bombay this was found to give a favourable effect on germination, being pronounced even in the adverse conditions of either soil or climate.

Experiments in Mysore on sugarcane stressed the importance of applying sulphate of ammonia before the plant was thirteen weeks old.

Experiments to determine the most appropriate time for the application of artificial manures to paddy were conducted at Sabour in Bihar with 120 lbs. of Ammophos per acre. The application of artificials two weeks after transplanting gave the highest yield.

In Sind, several replicated experiments laid out in an area depleted of its natural fertility by continuous cropping brought out the following points :—(1) continuous cropping with wheat and

juar can make the soil 'sick'; (2) allowing *juar* to reach maturity exerts a definitely adverse influence on the subsequent wheat crop; and (3) an enormous improvement can be effected in a single season either by green manuring or by a summer fallow.

(*b*) ***Fertilizers and crop quality.***—At Mysore, investigations into the rate of assimilation of plant food in *ragi* cotton and Virginia tobacco in the presence of alkali led to the conclusion that in the case of *ragi* and cotton, nitrogen was the deciding factor, while potash and phosphate occupy minor places. Tobacco suffered considerably when the soil contained one part of alkali in 10,000 parts.

Studies into the quality of coffee conducted by the United Planters' Association, South India, emphasised the need of an adequate supply of potash and a particular carbon/nitrogen ratio for the proper development of the berry.

The observation that the seed obtained from an intensively manured plot when sown gave a better yield than that obtained from a poorly manured one, was tried on sugarcane at Anakapalle in Madras.

The effect of phosphatic manures on the quality of cane juice was tried at Bombay. It was found that a treatment of farmyard manure and super-phosphate (5 : 1) gave higher tonnage and greater purity of juice than all other phosphatic manures.

At Pusa, investigations into soil acidity and lime-requirement in relation to crop characteristics led to the conclusion that the yield of barley increased gradually over control up to additions of lime equivalent to twice the lime-requirement and then gradually fell down.

A direct relationship between top-bottom ratio and purity of juice was found in healthy canes. No such relationship could be found in canes lodged or attacked by borers. In case of canes treated with different manures and which were not attacked by borers, the above correlation could not be established.

In the United Provinces farmyard manure has been found to give a greater yield and a greater sucrose percentage in juice and cane than chemical fertilizers.

In the Sugarcane Stations of Shahjahanpur and Muzaffarnagar it has been found that the limit of profitable nitrogen application is reached at one hundred lbs. The general trend is one of falling sucrose with increase in nitrogen. Earlier planting has been found to be favourable regarding yield as sucrose percentage.

2. Agricultural Meteorology

General.—In pursuance of the policy indicated by the Imperial Council of Agricultural Research, the Agricultural Meteorology Section of the Meteorological Office at Poona continued to devote most of its time to work on the " experimental or biological " and the liaison aspects of the scheme so as to maintain effective contact with agricultural institutions and workers in India and with the meteorological aspects of their respective problems.

Co-operation was extended to a number of agricultural workers by advising them about standard meteorological equipment and its installation in farm observatories on selected sites, training their assistants in observational work and repairing or standardising their instruments when sent to Poona. Workers at some of the representative agricultural centres in India have begun to co-operate with the section in conducting fundamental work on the climates of crops and precise measurements of their growth and yield. Enquiries relating to the meteorological aspects of their investigations were also received from several officers in charge of research schemes (*e.g.*, the dry farming, sugarcane research, locust and cereal-rust schemes) inaugurated by the Imperial Council of Agricultural Research. These enquiries often proved to be the starting points of some of the investigations undertaken by the section.

After consulting the Government of India as well as the India Meteorological Department, the Imperial Council of Agricultural Research informed all Provincial Governments and those Indian States which contribute to the funds of the Council that the

facilities for training in agricultural meteorology available at Poona might be taken advantage of by them whenever required. Some of the Local Governments and Indian States have already sent workers for training and some others have intimated their desire to do so.

At the instance of the Imperial Council of Agricultural Research, arrangements were made by the India Meteorological Department as an experimental measure to issue cold wave warnings to those Provinces and Indian States which are liable to the incidence of frost in winter. Various methods of frost-prevention were discussed with the Department of Agriculture, Bombay, and experiments to test the efficacy of different types of fires, wind-screens and irrigation were conducted in January and February, 1936, in collaboration with the Deputy Director of Agriculture at Nasik. A camp observatory was installed at Nasik to help in the above experiments. These experiments will form the basis for advice to the grape-growers regarding protective measures against frost-damage.

At the request of the Government of Bombay, a provisional scheme for the issue of heavy and untimely rainfall warnings as well as cold wave warnings by the Forecasting Section of the Meteorological Office at Poona to the various districts of the Bombay Presidency was drawn up in consultation with that section and Collectors of districts. This scheme was to be tried as an experimental measure for two years with effect from June, 1936.

Experimental.—The Central Agricultural Meteorological Observatory at Poona continued to be the main centre for experimental investigations. Investigations were carried out on the climates of different crops as compared with those of neighbouring open spaces and precisive observations were made on the growth and yield of crops. A number of new instruments of local construction were tested. Arrangements were also made during the year to complete the equipment for investigating the "thermal balance" as well as the "moisture or water balance" at the earth's surface. An instrument for the measurement of heat-loss by convection near the ground and another for the direct measurement of soil-moisture

by using a porous candle manometer may be mentioned in this connection. Besides regular observations of evaporation from soil and water surfaces, of radiation from the sun and sky, etc., the experiments on control of soil-temperatures by using thin soil-covers and the variation of soil-temperatures in blocks of different soil types were also continued.

The investigations on the exchange of moisture between the soil and the air-layers near the ground during the clear season show that this phenomenon sets a limit to the loss of moisture from the soil, once a dry surface-mulch is formed. The effect is most pronounced in the case of the black cotton soils and least so in the case of alluvial soils. Further work is in progress.

Statistical.—A number of statistical investigations were also in progress during the year. The study of weather in relation to the cotton crop in the Bombay Presidency and a statistical analysis of rainfall in the Mysore State were completed. A study of the correlation coefficients of monthly maximum temperatures between successive months at representative stations in India showed that the centre of high correlation moves down to South India during winter and returns to North-west India with the onset of the South-west Monsoon, thus indicating that the areas for which a prediction of maximum temperature may be possible by statistical methods would vary with the seasons. These movements of the area of high correlation are associated with the movement of the sub-tropical belt of high pressure in India. A study of the effect of rainfall on the yield of cotton at Akola was completed during the year. A preliminary examination of the yield-data for some of the important crops at Government farms in the Central Provinces and the Bombay Presidency for periods varying from ten to twenty-six years was also made. Another important investigation which was in progress was on the prediction of minimum temperature at selected stations in India during the clear season from a knowledge of the afternoon temperature and humidity.

Statistical advice was given to numerous workers interested in agricultural meteorology.

Agricultural Meteorology at the Conference of Empire Meteorologists and the International Commission on Agricultural Meteorology.—A report on the progress of agricultural meteorology in India during the period 1932-34 was sent to the International Commission on Agricultural Meteorology which met at Danzig in August 1935. Memoranda on various important items in agricultural meteorology were also forwarded and discussed at the Conference of Empire Meteorologists which was held in London earlier in August 1935. The Director-General of Observatories attended these meetings on deputation by the Government of India.

Post-graduate training in agricultural meteorology.—Six voluntary research students were working at Poona under the guidance of the Agricultural Meteorologist. Their loyal and enthusiastic co-operation was of great help in making progress on a number of investigations. Some of these workers were also busy preparing their theses for the M.Sc. degree.

Publications.—During the year under review the staff and research students of the section published thirteen original papers describing the results obtained on a number of important problems on agricultural meteorology. Besides these, a number of other contributions were in course of publication. These publications were widely appreciated by workers both in India and outside.

3. Plant-breeding and Genetics

Under the various crops dealt with in the chapter on 'Economic Work on Crops' most of the information on plant-breeding and genetics has already been given. In this section it is only proposed to review briefly certain matters of general or scientific interest.

Cotton. In the PUNJAB, the cross between cotton No. 15 Mollisoni and Million Dollar was given the name of Jubilee Cotton. In 1935-36 it was tested for field and factory performances for the first time. It combines the habit of growth of Mollisoni and fibre-characters almost similar to 4F, *i.e.*, where Mollisoni spins 6's to 8's, this Jubilee Cotton spins 15's to 18's. This cotton is an excellent example of the combination of the habit and physiology of one type with the long, fine lint of another. In MADRAS, investigations on the inheritance

of characters in cotton gave some interesting results. Deeper shades of pollen colour were found to be controlled by an intensifying factor which is operative only in the presence of the factor for red petal colour. In the CENTRAL PROVINCES about 140 strains of Bani×*cernuum* were under observation in small blocks and some of the more promising of these were grown in larger blocks. The hybrids have a very fine silky staple measuring $\frac{7}{8}$″ to 1″. In SIND, it is important that a cotton strain shall withstand Jassid attack and 'red leaf' disease. The improved strains of the African A/12 have given a good performance in this respect, while selections from K T and N T types of American cottons originally imported into Thar Parkar district from the Punjab did not maintain their original staple-length and were badly affected by Jassids. Four improved strains of the cross 4F-18×Meade have been fixed and grown on a field scale. Two of these mature early (by the end of October and middle of November) and the other two later by the end of December. The two latter varieties are superior to Sind Sudhar 289-1 in fibre properties and spinning performance. In BOMBAY, the Cotton Breeder at Broach has obtained a new strain called 'New Selection 49' which is wilt-resistant in the field and possesses other desirable characters. The cross B D 8 × G A 26, now in its fifth generation, has given some very promising selections with a staple-length of more than 22 mm., silky fibre, good ginning percentage and high wilt-resistance. The New Selection No. 12 from Broach, which is under very severe test for wilt-resistance in Poona, showed a percentage of survivals under the most extreme conditions of infection.

Wheat. In the PUNJAB, Cross 591 has been on the approved list and under distribution for the last two years only, and on account of its superior grain and fairly good yielding capacity, a demand has arisen in excess of the available supplies. This cross is now quoted in the Okara market separately under its own number—a unique distinction—and fetches a premium of four annas or even more per maund. Its reputation has spread beyond the limits of the Punjab. In SIND, the hybrids A T 38×Pusa 12 Strain No. 139 and C Ph 47 ×Pusa 12 Strain No. 37 were grown in the F_8 generation and found

to be distinctly high-yielding. In BOMBAY, a hybrid called Bansipalli 900 is exceedingly early but unsatisfactory in yield. An interspecific cross (Bansipalli ×Pusa 4) has given some valuable material during the year. A culture was found which has very large grain and in general resembles *Triticum polonicum*. The generation was F_2 grown of Bansipalli 808×Polish. F_1 and F_2 were also raised of Bansipalli 808×Punjab. In the CENTRAL PROVINCES, three of the strains from the hybrids, obtained by crossing A 115 with foreign wheats, were again reported to have shown a higher degree of resistance to rust than A 115 on Government farms in the Northern Circle.

Rice. At Coimbatore in MADRAS, the hybrid strains of rice bred for resistance to *Piricularia* have done very much better than the susceptible veriety Korangusamba in a season which was particularly favourable for the spread of the disease. In consequence, it is proposed to release for distribution a strain suitable for resistance to *Piricularia, viz.*, Strain No. 10998. A cross from Co 3, which is better than Co 3 both in yield of grain and strength of straw, is No. 10905 now available for release. This is the first hybrid strain produced on the Paddy Station. Results of very great scientific interest have been obtained during the year from a study of several mutations isolated from x-ray progenies. The close relationship between genetics and cytology is particularly evident in the study of the mutations for sterility. The study of special crosses with polyploids and the study of mutants are expected to be of considerable help in determining linkage groups. In BOMBAY, from the heterozygous culture known as " K 401 " some early fine selections were grown during the year of which one appears promising. Work was continued on several other varieties. Selection work in the rices of Lower SIND has resulted in the evolution of high-yielding strains of the variety Ratyra, some of which gave 36 per cent higher yield than the local. In the PUNJAB investigations on a cross of 370 Basmati and 46 Palman and a natural cross of 278 Sathra are in progress. In BENGAL, paddy strain No. 1(6) (capable of standing medium depth of water up to 6′-7′) has already been sent out into districts. Four strains Nos. 834, 817, 809 and 792 have been

developed which can stand water up to fourteen to fifteen feet. In BIHAR work on the selection of saline-resistant varieties is being done at Sabour.

In BURMA, there was a continuation of the study of the inheritance of sterility and partial sterility in certain crosses with Blue Rose, of the size and shape of grain in certain F_2 hybrids, of the endosperms in certain hybrids and of the more important field characters including grain shedding in certain hybrids. At the Rice Research Station in Nagina in the UNITED PROVINCES, over a thousand hybrid strains were under investigation. Success was obtained in crosses with Sathi rice whereby the hybrid obtains protection from the Rice Bug by means of the flag in which the head remains more or less enclosed. In the CENTRAL PROVINCES success has been attained in breeding colour into hybrid strains to distinguish them from the wild rices. In ASSAM, a new hybrid Ar C 353-148—a cross between Latisail and Sailbadal—is found satisfactory owing to its good yield and earliness.

Millets. In MADRAS during the year a good deal of additional knowledge has been gained on the inheritance of characters of *Andropogon Sorghum*. The wavy margin of the Milo leaf was observed to behave as a simple dominant to the straight margin of Kafir and the drying-up nature of the leaf margin in Milo was a simple dominant to the non-drying condition in Kafir. In grain-shape the umbonate grain of Kafir behaved as a simple dominant to the rounded grain of Milo. In BOMBAY the botanical analysis of the Poona, Akola and Niphad *bajri* strains has been conducted for three years. Results indicate that, as a population, the Akola variety has advantages over the Poona strains in—

(1) better field germination,
(2) lateness,
(3) higher number of nodes,
(4) a well-filled ear-head,
(5) a larger size of grain, and
(6) a much better crop-stand.

In SIND, special attention was given to the improvement of fodder *juars*. The New Selection Acho Kartuho Turi No. 56 ×

Saoro Kartuho No. 1, made with the object of obtaining a type suitable for both fodder and grain production, was grown in the F_2 generation. Further botanical work is in progress on single plant selections. A long-headed type obtained from the Karachi district appears to be promising. In the PUNJAB, mass selection of *bajra* has given useful results and a few early cultures have been isolated. In *juar*, J-8 once again showed its superiority over the local. A new type No. 908 has been separated and under preliminary trials at Lyallpur has given satisfactory results.

Sugarcane. During the year Co 421 was added to the list of parents yielding vigorous types. The sorghum hybrids are showing remarkable figures in the matter of sucrose, one of them recording over twenty-one per cent in bulk samples. In cyto-genetic studies the following crosses have been affected :—

(1) Interspecific crosses between the different chromosomal types of *S. spontaneum*,

(2) Interspecific crosses between the variety Vellai as the mother parent and types *S. spontaneum* and *S. Robustum*, and

(3) Intergeneric crosses.

Potatoes. At PUSA and at SIMLA, a considerable amount of material of South American and Central American species of hybrids between these and *Solanum tuberosum* have been studied. This material was received through the courtesy of agricultural botanists in Russia, America, Germany and England. Dr. P. S. Hudson of the Imperial Bureau of Plant Genetics, Cambridge, Dr. R. N. Salaman of the Potato Virus Research Institute, Cambridge, were specially helpful. Most of the species (other than *S. tuberosum*) were reported to require " short day " conditions. Plants of such species were covered for the necessary period with improvised dark cloth-covers. Surprisingly enough, plants left uncovered as controls also formed tubers. This matter therefore requires further study. The following crosses were successfully made and a quantity of seed obtained :—

Pusa White × *S. demissum*,

Pusa White × *S. neoantipoviczii*,

Coonoor White × *S. andigenum*,
President × *S. andigenum*.

Tobacco. The study of the cross between *N. Tabacum* and *N. plumbaginifolia* was completed. The hybrids were completely sterile and showed a number of features, *e.g.*, striping and streaking of flowers not found in either of the plants. This is the first time that plants from this difficult cross have been successfully raised to maturity. At the Nadiad Experiment Station in BOMBAY, further selections were made of the local varieties and their crosses.

Linseed. Further studies were made in order to obtain a correct genetic analysis and progress has been made in this direction. In a cross between a yellow-tipped mutant and its original type the green condition is dominant. The study of crosses between rust-resistant and susceptible varieties was continued. There was a heavy incidence of rust during the year. The Hybrid 68, which is early and has bold seed with a high oil-content, was favourably reported upon by the Burma and Sind Departments.

In BOMBAY, the linseed-breeding scheme financed by the Sir Sassoon David Trust Fund completed its second year. Single plant selections were tested for oil-content and quality of oil. Most of the cultures have retained their high oil-content and the drying quality of the oil. Twenty-two types from outside the Bombay Presidency are being maintained pure. As regards yield, with the exception of the strains from the Central Provinces and six Peninsular types from Pusa, none of the pure types from outside the Bombay Presidency equalled the local material in yielding capacity.

Brassicæ. A special technique has been evolved for distinguishing seed of *toria* (*Brassica napus* var. *dichoroma*), sarson (*Brassica campestris* var. *sarson*) and *rai* (*Brassica juncea*). The F_3 of *toria* and sarson crosses have yielded a large number of self-fertilized hybrids some of which may be of economic importance.

Groundnuts. From the interspecific crosses made between *Arachis hypogea*, *A. rasteiro* and between *A. rasteiro* and *A. nambyquaræ*, over 1,400 F_3 families and 179 F_2 families were studied during the season. Certain conclusions were drawn regarding the

inheritance of certain characters and a positive and significant relationship has been established between the ratio of the average length of the primary branches to the height of the main axis and the weight of pods.

Castor. In MADRAS, eighty-five economic selections and 160 types were grown for further inbreeding and multiplication. Five to fourteen per cent of the plants were found to be naturally cross-pollinated in a special experiment. In HYDERABAD (Deccan) selection work on castor has been continued. The mass selection seed of a red-stemmed type was demonstrated in the districts.

4. Plant Physiology

Almost all research work on agricultural plants has got a physiological aspect and this aspect is dealt with under each crop or group of crops in this publication. The present section deals, therefore, only with certain highly specialised researches of a peculiarly and narrowly physiological character.

Cotton. Work on cotton physiology in Sind during the *kharif* season of 1935 was concentrated upon the undernoted lines of investigation :—

(*a*) Water-requirements of improved varieties of cotton in Sind and irrigation technique in relation to yield.

(*b*) Manurial requirements of the cotton crop under Barrage conditions in Sind.

(*c*) Research work on the " red leaf " phenomenon on different varieties of cultivated cottons in the Barrage areas.

The results of experimental work on the water-requirements of the cotton crop in Sind and on the economics and technique of the application of irrigation water in relation to yield, which were obtained in previous years, were confirmed during the year under report. These results have now been published in an Agricultural Leaflet (No. 51) " The Irrigation of the Cotton Crop in the Barrage Areas of Sind ". Studies of the nutritional requirements of the cotton crop at different stages of its growth have been continued. With regard to the application of inorganic nitrogenous fertilisers, *e.g.*, sulphate of ammonia, there are clear indications that such

applications are most profitably applied either at the commencement of intense flowering in August or, in two doses, the first during the early vegetative period of growth in June and the second, during flowering in August. Further manurial experiments are in progress

The complex phenomenon of the appearance of " red leaf ", especially on American varieties of cotton under cultivation in Sind, has been studied in detail. Several types of " red leaf " have been classified and the causative factors of each type are under investigation. The results obtained have been embodied in a separate report for submission to the Indian Central Cotton Committee. Additional physiological studies of the cotton plant under Sind conditions included detailed measurements of periodic height and diameter increase, percentage of dry matter, ratio of flowers to bolls, etc., under different irrigational and manurial treatments. Information was collected regarding the nitrogen-content of the plant, especially the leaves and fruiting organs, at different stages of growth. Detailed meteorological observations were maintained by the staff of the Physiological Section with the object of examining the relations existing between temperature, humidity, etc., of the soil and air and the physiological processes of the development of the cotton plant under Sind conditions. Minor investigations into the factors resulting in the production of unsound seed by the cotton plant, the effect on fibre-characters of different irrigational and manurial treatments of the crop and the fertility value of rotations of cotton with *rabi* leguminous crops, *e.g.*, berseem, were continued.

The Indian Central Cotton Committee financed a special physiological research to study the phenomenon of cotton failure in the Punjab. This scheme started in March 1935. Certain un-identified organisms were discovered in the plant and the seed (except in the embryo), but these did not appear to have any causal relationship with the so-called failure, and inoculation with these organisms failed to reproduce the disease. Diseased plants showed a disintegration of chloroplasts in the leaves and a general breakdown of the carbon-assimilating mechanism. There were also found an accumulation of starch in the roots and leaves, the presence of tannin derivatives in the roots, stems and leaves, the accumulation of

organic acids, the accumulation of calcium in the form of salts of organic acids in the roots and precipitations of proteins. Further work is being directed to discover how far these symptoms are influenced by soil conditions.

In the Madras Pampheres and Physiological Schemes, evidence of a fairly close association between the extent of water-soluble polysaccharide contained in the stem and the readiness of the plant to produce gum to control the attack of the insect has been obtained.

In the Central Provinces the physiological work carried out by the section was continued on the lines of the past season. A series of daily observations of growth, flowering, bud and boll-shedding and boll-opening were made, in order to study the effects on the plant, of climatic conditions and other factors. These have been represented in graphs for reference and comparison with other seasons. The study of the effect of various cultural and manurial treatments upon the cotton plant was also carried on and the results obtained have been recorded in the annual report of the Akola farm. The " time of sowing " experiment was continued as in the past season. Four sowings were made on different dates with an interval of seven days between each sowing, commencing on the 13th of June and the experiment was duly replicated. The second sowing again gave the highest yield, thus confirming the results of last year that early sowing gave a higher yield.

Rice. Following up the reported results of Prof. Dastur's work on rice physiology a considerable number of research stations carried out field tests to study whether sulphate of ammonia, nitrate of soda or a mixture of the two gave the best results. Only in Travancore on poor laterite soils was the mixture of ammonium sulphate and sodium nitrate decidedly better. In other provinces either ammonium sulphate turned out to be the best or else there was no significant difference between ammonium sulphate and the mixture of ammonium sulphate and sodium nitrate.

Sugarcane. Physiology of sugarcane has been studied at various centres. In Bombay, further research in bio-climatics has shown that other factors such as velocity of germination and fluctuation in the sub-soil water-table exert their influence on the

crop-growth and thus mask the effect of climate to some extent. Humidity is also found to accelerate the activity of the top-borer. The incidence of its attack is, however, greatly reduced in case of early vigorous germination. Detailed investigations in the movement of soil-moisture have revealed that from the standpoint of water-requirement the early grand period stage (mid-May to end of June) is the most critical period in the event of the late approach of monsoon and it is at this stage that the treatment of 70" falls definitely short of the crop-requirements. On the other hand, heavy irrigation of 130" necessitates higher manuring as it leads to both leaching down of the soluble nutrients and the checking of the activities of the soil microflora. On the manurial side, the findings on the periodical mineral requirement of the crop have been tested in a replicated trial with promising results. Experiments with varying quantities up to 300 lbs. nitrogen have shown that, from the standpoint of yield and mineral intake, the optimum dose has not been reached and investigation is therefore in progress with still higher doses up to 600 lbs. nitrogen. The germination studies have also yielded information of great practical value as regards the selection of buds and optimum field conditions. Investigations are also in progress on the utilisation of trash and molasses by direct incorporation in the soil as well as on the factors affecting the quality of *gur*.

In the United Provinces, physiological investigations included the study of the inter-relationship effects of nitrogenous manuring, irrigation and date of planting upon the germination, growth and yield of sugarcane; the effect of spacing and nitrogen application upon growth and sucrose and purity; and the effect of climatic conditions upon the growth of the plant.

In the Punjab a serious physiological disorder causing yellowing of leaves has been discovered in sugarcane crop in the Karnal district. Application of iron sulphate solution helped in the restoration of green colour. This problem is under investigation. B. N. Singh and S. C. Chakravarty studied the influence of solutions of varying hydrogen-ion concentration on the germination and early growth of cane. A positive correlation between germination energy

and output of dry matter appeared to exist. The maximum growth was found to occur at *p*H 6 to 8.

The best result for seed root-growth was obtained by a forty-hour treatment, while for the growth of the shoot, the best period was twenty-four hours.

Tea. Research work at the TOCKLAI Experiment Station of the Indian Tea Association shows that, if a bush is pruned and then left to grow unplucked for the rest of the year, the flush periods of this pruned bush do not necessarily correspond with the flush periods of a similar bush which has never been pruned. But the crop-production of a bush which is plucked at regular intervals has been shown to be associated with the flush periods of a similar pruned but unplucked bush. It has also been shown that the common usage, amongst planters, of the term " flush ", agrees with the definition given above : when the planter speaks of " a good second flush " he is referring to an amount of growth made during the second growth-period (or flush period) of the year ; similarly, by " during the second flush " is meant " during the second flush period ". The physiological activities of the tea bush may be correlated with its flush periods and one may enumerate changes in crop, response to pruning and to plucking, hairiness of the leaf (and consequently " tip "-producing capacity), almost certainly bacteria on the green leaf and chemical composition of the leaf, as being closely correlated with the flush periods. The sum total of changes in all these factors must have its reflection in changes in the quality of the manufactured tea. Rather than saying that the physiological activities of the tea bush may be correlated with its flush periods, it would be more exact to say that the flushes are a structural reflection of underlying physiological activity.

Other physiological researches. A research financed by the Imperial Council of Agricultural Research on the effect of ions on the growth of plants carried out by Bhatnagar and Mathur has given the following results :—

1. Salts of uranium, thorium, cerium, manganese and zinc generally accelerate the growth of the plants as measured by the increase in height and the total dry matter of the plants. The

concentration of the salts even of the order of 1×10^{-7} mols in culture solutions was found to be very effective which shows the possibilities of incorporating the necessary quantities of the effective ions in the soil, either by treating the soil with salt solutions or by mixing with adequate quantities of sand rich in radio-active salts and other active ions.

2. On soaking the seeds in the dilute solutions of the salts, the seeds assimilate the necessary quantity of the salts. The absorbed ions retain their active properties and the seeds thus impregnated germinate more quickly and show marked increase in the total weights and lengths in the early stages of plant growth.

The process of soaking the seeds in the salt solutions affords a very convenient way of improving the plant-growths or the subsequent yield. Attempts in the present work have mainly been concentrated to collect data in culture solutions and in sands only. In a few cases, however, some results have been confirmed in plots especially constructed for these experiments.

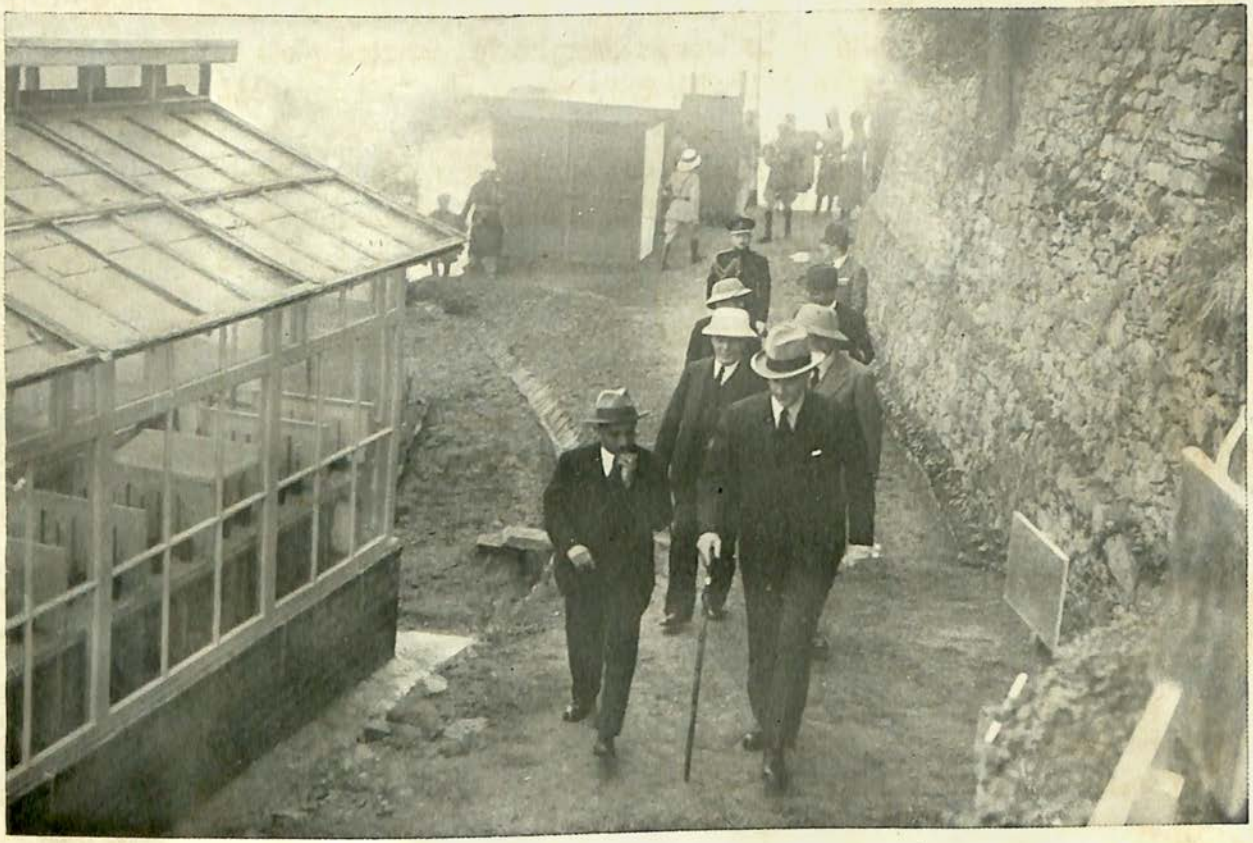
The values shown in the report are the means taken over a large number of plants and almost in every case the results in culture solution have been confirmed in sands or in the plots. It is hoped the data furnished in this report will be of immense help in conducting further work on field experiments and will find application in the improvement of manures and the yield in crops on a large scale.

Plant Diseases

Rice. Investigations in the PUNJAB on the stem-rot disease of rice showed that the disease is caused by *Sclerotium oryzae* which seems to be soil-borne. Experiments at PUSA had given negative results, but under the Punjab conditions this fungus appears to be pathogenic.

A sterility disease of rice in the CENTRAL PROVINCES was found to be due to an eelworm—*Aphelanchoides* sp.

The chief disease of rice in SIND is caused by *Helminthosporium oryzae.* The method of control by seed-treatment was not very promising, due to secondary infection. Further investigations upon the development of resistant varieties have given encouraging



His Excellency Lord Linlithgow arriving at the Rust Research Laboratory, Simla. Dr. K. C. Mehta showing one of the greenhouses.

results. The type evolved and known as " Silver Jubilee " has shown considerable resistance.

In MYSORE steeping of seed in Uspulun and Ceresan solutions was tried to control the *Karikaddiroga* disease. The application of a small quantity of copper sulphate to irrigation water was found to be effective against a disease locally called *Seegade sette.* The disease was found to be less in completely manured plots as compared to those manured with only nitrogen or nitrogen and phosphoric acid.

Wheat. Investigations carried out at KARNAL by the Mycological Section, Pusa, showed that wheat seed, given hot-water treatment against " loose smut " and subsequently stored, suffered a more rapid loss in viability than untreated seed. This appears to be connected with the physical effects of the treatment, *viz.*, removal of wax, cracking of endosperm, etc. Hot-water treatment should, therefore, be applied immediately before sowing.

Experiments at Karnal showed that wheat bunt (*Tilletia indica*) is soil-borne as well as seed-borne. Experiments are in progress to test the efficacy of certain rotations in soil infected with *T. indica.* Measurement of a large number of healthy and bunted ears at Karnal indicated that bunt infection reduces both the length of ears and the number of spikelets. Pusa 120 has been found to possess high resistance to the physiologic races of yellow and brown rust and will be used for breeding rust-resistant wheats. Sun-heated water methods to control loose smut in wheat have been found successful under Bihar conditions.

Experiments to control ' foot-rot ' of wheat caused by *Helminthosporium sativum* showed that Ceresan treatment reduces the seedling death.

" Flag smut " (*Urocystis tritici*) is assuming a serious form in various parts of the PUNJAB. It has been found to be both seed-borne and soil-borne.

The problem of wheat-rust dissemination was further studied under the scheme financed by the Imperial Council of Agricultural Research. The pathogenicity of the all three physiologic forms of yellow rust of wheat was tested on seventy wheat types,

and the seedling resistance, in the green house, of forty-eight types to four physiologic forms of black rust was also tested. Forty-one types were tested with the two forms of brown rust. An intensive search for early appearance of rust on wheat and barley was made with the kind co-operation of the Government of Nepal.

Studies in the life-histories of the rusts were continued both at Simla and Agra. The work on the breeding of wheat resistant to known physiologic forms of the three rusts was started. Resistance was found to be dominant in certain cases and susceptibility in others. A collection of 106 wheat samples from various foreign countries was under study with the object of discovering strains suitable for breeding rust-resistant varieties.

Oats. Germination tests with smut spores of oats and barley at PUSA showed that spores do not lose their viability if kept in sealed glass-tubes or air-tight containers. Seeds of 101 types were treated with smut spores and germinated. The degree of susceptibility of the different types is being compared.

Juar. In the CENTRAL PROVINCES copper carbonate, sulphur, Abavit B and Agrosan G have been found to be equally effective for the control of *juar* smut—*Sphacelotheca sorghi*. In the control plot the percentage of smutted heads was 11·2, whereas in plots with treated seed the percentage varied from 0·8 to 0·2.

In the BOMBAY Presidency investigation on *Macrophomina phaseoli* showed that sixty-five per cent soil-moisture with a soil temperature of 35·5° C. produced the optimum condition for the disease.

Maize. A leaf disease of maize caused by a species of *Colletotrichum* was studied at PUSA and a study of morphological characters and the results of cross-inoculation experiments led to the conclusion that the causal organism is *C. graminicolum*. Another new disease observed on maize is a bacterial leaf-streak and was under investigation.

The downy mildew fungus of maize originally known as *Sclerospora maydis*, later renamed *S. indica*, was reviewed in the BOMBAY Presidency. The comparative study of *S. indica* with *S. philippinensis* on maize in the Philippines has revealed that there is no ade-

quate basis for maintaining *S. indica* and *S. philippinensis* as separate species and the former has, therefore, been merged with the latter under the name *S. philippinensis*.

Sugarcane. The study of mosaic and other diseases of sugarcane was continued at PUSA under the scheme financed by the Imperial Council of Agricultural Research. Tonnage experiments conducted with Co 213 at Pusa revealed a loss of about nine per cent in the cane-yield due to mosaic. Similar experiments are in progress at Karnal with a thick cane variety (Saharanpuri Surkha) to see the effect of mosaic on yield. Thick varieties are known to suffer heavily in other countries.

From the fundamental aspect of mosaic-virus study, much information has been accumulated regarding the physical properties, transmissibility of sugarcane-mosaic virus and the effect of chemicals on it. The chief points of interest are: (1) Mosaic-affected setts do not all of them give rise to mosaic-affected plants. Some of the plants are perfectly healthy and free from any mosaic symptoms. Such recovery is greater when basal setts or setts from the middle portion of the cane are planted. (2) Mosaic leaf-juice treated with alcohol (ten per cent and twenty per cent), toluene (five per cent), chloroform vapour (saturated), carbolic acid (one per cent), and formaldehyde (one per cent) showed that with the exception of the last two the infective principle of mosaic juice does not seem to be affected. On the other hand, exposure of chloroform vapours appears to have some activating effect on the mosaic virus. (3) Temperature is the most important factor in the storage-life of the mosaic virus; mosaic leaf-juice (from Co 213) stored at 0° C. was found to be infective even after the lapse of ninety-six hours, while at the ordinary room temperature (20°-22° C.) infectivity is lost after two hours' time. (4) Unlike many viruses, the sugarcane mosaic virus is very sensitive to dilution. It loses almost all its infectivity when the mosaic leaf-juice is diluted to 1 : 100. (5) Thermal death-point determinations suggest the existence of more than one strain of sugarcane-mosaic virus. The Co 213 strain is inactivated at about 45° C., the Saretha strain at about 50° C., while Co 313 and M-16 mosaic viruses show no appreciable loss of their

infective power even after heating at 50° C. Further heating at 60° C. inactivated the Co 313 virus, but M-16 virus still retained some (ten per cent) infective power. (6) P O J 2878 was found affected with mosaic, which is rather interesting, as P O J 2878 is a variety considered almost immune to mosaic.

Various strains of *Colletotrichum falcatum* were isolated and inoculation experiments were carried on with different varieties of canes. It appears there are several physiologic strains of the ' red-rot ' organism.

Seedling diseases caused by *Helminthosporium halodes* and by *Pythium graminicolum* were studied. A bulletin entitled " Diseases of Sugarcane and Methods for their Control " has been published. This publication will be of great help to all concerned with cane cultivation.

In the CENTRAL PROVINCES sprinkling the soil round plants infected with ' Striga ' with copper sulphate again gave satisfactory results.

In MADRAS twenty-eight varieties of canes were tested for their relative susceptibility to mosaic under field conditions. Varieties Co 353, Co 411 and Co 412 showed a high degree of resistance.

Cotton. In the CENTRAL PROVINCES experiments for the control of seedling diseases were continued. The death of seedlings from Anthracnose in the plots sown with seed delinted with sulphuric acid was much reduced. In plots sown with seed dusted with various mercury compounds and other fungicides, the percentage of death from Anthracnose was more or less the same as in the control plots. The highest death-rate of seedlings was in the late-sown plot.

The study of cotton root-rot, financed by the Indian Central Cotton Committee, was continued in the PUNJAB. The causal organisms (*Rhizoctonia solani* and *R. bataticola*) live in the soil on decayed as well as on living cotton roots. The same organisms infect several other crops. It has been found that fifteen to twenty per cent of soil moisture causes the maximum attack. Cotton, sown late in June, showed almost a complete freedom from root-rot, while that sown early in May was heavily attacked.

Tobacco. The study of ' black shank ' disease of tobacco was continued at PUSA. A variety that appeared to be resistant to this disease is being tested.

In MADRAS experiments carried out to find out suitable remedial measures against " black shank " showed that the disease could be controlled by (1) sterilization of the seed-bed by burning trash, (2) disinfection of seed by treatment with dilute silver nitrate and (3) protection of plants in the nursery and in the transplanted field by spraying with Bordeaux mixture. Out of fourteen varieties Adcock, Cash and Shade were found to be resistant to this disease.

Gram. The study of the gram-blight disease caused by *Mycosphaerella rabiei* was continued in the PUNJAB and several control measures were tried. As soon as stray cases of disease appeared, the affected plants were pulled out and destroyed. Destruction of the debris of the diseased plants, after harvesting and threshing, has proved an effective control measure. Three French varieties have been found to be resistant to this disease.

Pan (Piper betle). A series of experiments to obtain further information as to the cheapest and most efficient soil treatment against *Rhizoctonia solani* failed to give satisfactory results owing to the poor development of the parasite at PUSA. Similar experiments are also being tried in BENGAL.

Groundnut. In the CENTRAL PROVINCES the incidence of *Tikka* disease caused by *Cercospora personata* and *C. arachidicola* was controlled by timely spraying with Bordeaux mixture, to which linseed oil or Agral was added. Two sprayings, one in the beginning of August and the second a month later, were found to be sufficient; if the weather is very wet in September, another spraying may be necessary. The treated plot gave a higher yield of nut.

Sann-hemp. An Anthracnose disease caused very severe mortality among sann-hemp seedlings in PUSA. The causal organism was found to be *Colletotrichum curvatum* recorded previously in the West Indies, but not hitherto reported in India. Seed-treatment

controlled the disease to some extent. Spraying gave considerable protection.

Coconut. The diseases of coconut palm continued to be investigated in TRAVANCORE. The wilt or root disease received the greatest attention. Regular cultivation and judicious manuring helped the infected trees to thrive in spite of the disease. The etiology of the disease still remains obscure. Several fungi were isolated but so far no positive results have been obtained from infection experiments. The leaf-blights due to *Pestalozzia* sp. and *Helminthosporium* sp., leaf-rot, bud-rot and stem-bleeding diseases were also under study.

Arecanut. In ASSAM ' bud-rot ' (bacterial) caused a considerable amount of damage throughout the province. The disease is gradually increasing and has become a serious problem to the growers. All diseased plants are being cut and burnt. The ' bleeding disease ' is also common and does a good deal of damage. It was found that, if diseased tissue is removed at an early stage and hot tar is applied, the disease could be easily controlled.

The *Mahali* disease was again a source of considerable trouble in TRAVANCORE. Campaigns of spraying with Bordeaux mixture were organised and during the year more than 17,000 trees were sprayed.

The *Koleroga* disease appeared for the first time in a number of new localities in MYSORE. The addition of ground-nut oil as a spreader for the spray has become popular. The use of molasses as a spreader is being continued as an experiment. Similar to casein, molasses also seem to have a retarding effect on the settling down of the Bordeaux precipitate and thus prevent its rapid deterioration.

Tea. The diseases of the tea bush were studied by the Mycologist to the UNITED PLANTERS' ASSOCIATION OF SOUTH INDIA. The leaf-disease caused by *Cercosporella theae* was identified for the first time in Southern India. High humidity appeared to be necessary for the propagation of the fungus. The disease incidence greatly diminishes with the advent of dry weather. The fungus

has also been recorded on *Eucalyptus robusta, E. diversicolor, Acacia dealbata* and *A. melanoxylon.*

Violet root-rot caused by *Sphaerostilbe repens* was also recorded for the first time from South India. This fungus is a common root parasite of rubber, jack fruit and of several jungle plants all over the tropics. The disease manifests itself on bushes growing in bad soil conditions especially when the soil is clayish and ill-drained. Control measures against this disease should aim at improving soil conditions, particularly drainage. The infected bushes should be pulled out and burnt. Several treatments of soil were under investigation.

The Mycologist to the INDIAN TEA ASSOCIATION at TOCKLAI, Assam also investigated the disease caused by *Sphaerostilbe repens* (*Violet root-rot*). A disease of seedlings due to eelworm was also under study.

Coffee. In South India the study of inheritance of resistance to *Hemileia vastatrix* was continued. Two physiologic strains of this rust were isolated. Strain I was found to be capable of attacking 'Coorg coffee' but unable to attack certain 'Kents'. Strain II was found to be capable of attacking both 'Kents' and 'Coorgs'. A number of plants resistant to both these strains have been found out and such plants appeared to show a complete resistance in the field. A third strain of the rust was later noticed. This was able to infect several plants which showed resistance to Strains I and II.

Fruit trees. The diseases of fruit trees were studied in BALUCHISTAN. The work was mainly confined to general survey and prophylactic measures. Different fruit trees were sprayed at various stages and a number of fungicides were tried to find out the most suitable method of controlling diseases.

In the CENTRAL PROVINCES the canker of lemon fruit caused by *Pseudomonas citri* was successfully controlled by spraying with Bordeaux mixture.

In BOMBAY fig rust was controlled by spraying with Bordeaux mixture and Sulsol, but Bordeaux mixture was superior to Sulsol. Under Deccan conditions it appears that this rust perpetuates itself in the uredo-stage. The cause of citrus gummosis has been

found to be due to *Phytophthora palmivora* and several resistant varieties have been found. Various control measures were tried and were found to be successful.

In the PUNJAB the ' wither-tip ' disease of citrus trees was investigated. The disease, which is very destructive, is caused by *Colletotrichum gloeosporioides*. Various control measures were tried with success.

Miscellaneous. A comparative study of *Colletotrichum* spp. isolated from pulses was continued at PUSA. It appears that in addition to *C. lindemuthianum* there are at least two more species.

Urocystis sorosporioides was recorded for the first time in India on a species of *Delphinium* collected from Simla.

Diseased sweet potato was collected at Karwar and was found to be due to *Rhizoctonia solani*. This fungus causes shrivelling and a dry rot of the fleshy roots.

6. Entomology—Insect Pests

(*a*) *Locusts.* The Locust Bureau of the Imperial Council of Agricultural Research continued to receive information on locusts from all parts of India, and to compile and distribute locust-intelligence periodically.

Bionomics

Studies were continued at Lyallpur on the bionomics of the Desert Locust under controlled conditions of humidity and temperature. Experiments conducted to analyse factors responsible for the development of phase characters showed that a hopper attained *gregaria* coloration when it (i) lived in crowded conditions, (ii) was made to undergo muscular exertion, or (iii) lived in an atmosphere containing excess of carbon dioxide. The tentative conclusion was reached that the coloration phenomenon was in some manner connected with the respiration of the insect. The influence of excess of oxygen did not show any reduction in black pigment.

One of the implications of the phase theory is that the body proportions of locust are different in the two phases. Solitary hoppers, with similar ancestral history, and bred under different temperatures,

attained different sizes. The proportions of the different parts of the bodies of these locusts, in spite of their belonging to the same phase, were different.

Experiments were conducted to determine the temperature optimum for *Schistocerca gregaria*. Three criteria were decided upon, *viz.*, (*a*) growth as judged from size and weight, (*b*) reproductive power as judged from the number of egg-clusters laid and (*c*) mortality. The optimum temperature for the Desert Locust lies in the neighbourhood of 32° C.

The adverse influence of low atmospheric humidity on sexual maturation has been studied by several workers. Lately Hamilton has reached the conclusion that an adult does not attain sexual maturity as long as humidity is low. This, however, does not appear to be the case. It has been discovered that it is not atmospheric humidity that matters. What controls sexual development is the moisture in the body of the insect and this in its turn is regulated by the food which the insect eats, as all the moisture that a locust receives is through its food. Thus, whatever the atmospheric humidity may be, if a locust can get the required amount of water from its food, it matures in the normal time.

The Desert Locust often passes through an extra hopper stage. Such an adult can be distinguished by an extra stripe in the eye and by two extra segments in each of the antennae. It has been shown that the extra hopper stage as a rule goes with the solitary phase.

Experiments conducted to determine the comparative power of the black (*gregaria*) and green (*solitaria*) hoppers to tolerate solar heat have shown that a black hopper, when exposed to summer sun-light, becomes restless earlier and succumbs earlier than a green one. The degree of toleration shown by the two phases does not, however, appear to be significant.

Locust survey work

In view of the circumstance that specimens of the solitary phase of the Desert Locust were mainly to be met with either in the desert areas of Sind, Rajputana and South-west Punjab, or in the sandy *rek* areas of the Mekran coast, locust survey work was mostly restricted

to these areas. As far as possible, intensive rather than extensive survey work was aimed at, with the object of noting the fluctuation of the locust population and of studying the activities of the locust in response to the variations of climate during the different seasons of the year. Intensive surveys were in progress at particular centres typical of the different areas, such as Pasni, Gwadar and Ambagh in Southern Baluchistan, and at Chachro, Nokh and Sardarshahr (and also at Barmer till the end of March, 1936) in the Sind-Rajputana desert area. In addition, various parts of the Desert Locust habitat in Mekran, Lasbela and Rajputana were periodically surveyed by the survey staff. The survey work in the Sind-Rajputana area was controlled by an Assistant stationed at Barmer in Jodhpur State, while the work in the Mekran area was supervised by a Survey Assistant stationed at Pasni. In addition, observations on the climatic and vegetational conditions of the different areas were also made and recorded in connection with the ecological studies of the areas of locust habitat.

Ecological observations

Studies of the conditions under which the solitary phase of the locust exists in the natural areas of its habitat, such as the *reks* of the Mekran coast and the desert areas of Rajputana were in progress at Pasni and Ambagh and at the desert outposts of Chachro, Nokh and Sardarshahr. Detailed ecological work was, however, mostly concentrated at the Pasni Locust Research Laboratory which has been equipped with the necessary apparatus. At Pasni, moreover, experimental work in connection with the study of the number of generations possible in a year under semi-natural desert conditions, and of the effect on the sex-maturation of the locust of the quality of the food supplied to it was in progress.

The vegetation—annual as well as perennial—found in the different areas of the locust habitat was also studied in connection with its bearing on locust breeding.

Locust breeding during 1935-36

1. *The winter brood of 1934-35.*—Following heavy rainfall in the Mekran area from the middle of December 1934 to the middle of

February 1935, moderate to heavy breeding of the solitary phase locust took place on all the western coastal *reks* from Ormara to Gwadar, as also to a certain extent in the interior valleys, such as Kulanch, Kech and Kolwa. Adult locusts of the new generation began to appear early in April. As there was further rainfall in the interior of Mekran during April and May, 1935, hoppers of the second spring generation were noticed during May and June in certain parts of the interior. In three different places in Kech and Panjgur, the appearance of crowds of hoppers was reported among fields of *juar* in May, June and July. Since these hoppers were black in colour and were crowded together, they are, doubtless, to be regarded as incipient swarms of a gregarious character, that had come into existence as the result of crowded egg-laying by female locusts of the solitary type.

During July-August 1935, very large numbers of locust individuals (as distinct from locust swarms) were found appearing on the *rek* areas of Mekran and Lasbela and in parts of Sind, Rajputana and South-west Punjab almost at the same time. As many of these individuals showed biometrical ratios of the gregarious type, and a good many were also either pink or bright yellow in colour, it is to be presumed that they were of the transitional type of locusts from which swarms might be built up, should further multiplication occur.

There is little doubt that these forms had migrated into India from some western source, and quite possibly some of them had formed part of the incipient swarms produced in Mekran in May-June. Since the immigrants were, however, exceedingly numerous, it is probable that the greater part of them were extra-Indian in origin, and had possibly been produced in similar outbreak centres in Iranian Mekran and perhaps also in Eastern Arabia.

Summer breeding of 1935.—As there was no rainfall either in Mekran or Lasbela, no summer breeding was noted among the immigrants. In the Rajputana areas, however, there was fairly good rainfall in July and as a result, a fair measure of egg-laying and breeding occurred here, but as this was not followed by sufficient rainfall in August and September, subsequent breeding was

comparatively limited. Green hoppers were, however, being met with in various places in small numbers in the southern desert areas till the middle of November, the later batches evidently representing the second generation of the season. If the monsoon rainfall had been heavy during August-September, as in 1926, the resultant breeding might have proved heavy enough to lead to the building up of swarms, and perhaps to the commencement of a fresh cycle of locust infestation.

Winter breeding, 1935-36.—During the winter and spring months of 1935-36, the rainfall in the Mekran areas proved to be below normal, and locust breeding was consequently only slight to moderate both in extent and intensity. Green hoppers were found both on the coastal " reks " and in the interior, though only in small numbers.

Some results of locust research work in 1935-36

1. During 1935, fairly clear evidence was obtained as to the power of isolated locusts to migrate long distances from one rain-belt to another. In the Lasbela and Rajputana areas, the local locust population was very low, and in fact, practically non-existent till the middle of May, but by June and July, very large numbers of locusts were found arriving there. Again, during the autumn and winter months of 1935, locusts were found gradually diminishing in numbers in the Sind-Rajputana area, whereas their population was found gradually rising at the same time in the Lasbela and Mekran areas. As, moreover, the locusts noticeable at this time on these " rek " areas were clearly specimens of a recently developed generation, which could not have been produced locally in view of the want of rainfall and breeding, there is little doubt that they were migrants from the Rajputana desert area. In May-June, 1936, an immigration of " solitaria " individuals from the west was observed to occur almost simultaneously at Pasni, Ambagh and various places in Rajputana, thus confirming the observations in regard to the migration of the " solitaries " made during the previous summer.

2. As already stated, three instances of the production of incipient swarms as a result of crowded egg-laying by individuals of the solitary phase type were observed in the Mekran area. It is rather noteworthy that in all these three cases, the appearance of the incipient swarms had been associated with *juar* cultivation. Since it is the formation of such " outbreak centres " that ultimately leads to the commencement of a period of mass-multiplication of the locust, it is highly important that such cases of incipient swarming should be detected and controlled in time. Since it is probable that such " outbreak centres " exist in similar territory in Iranian Mekran, international co-operation is essential.

3. In the course of the experimental work at Pasni, to test the effect of different kinds of food in bringing about the sex-maturity of locusts, it was observed that among the wild food-plants of the locust, the tender parts of plants in a fresh condition had a greater effect than old or mature parts. It was also found that locusts fed on *juar* or maize leaves attained maturity in a much shorter time than on other food-plants,—an observation, which might prove to be a significant factor in the production of outbreak centres.

Locust movements

Except for a few swarms reported in the Khairpur, Jaisalmer and Bahawalpore States in July 1935, at the time of the locust incursion, movements of swarms have been conspicuously absent within Indian limits during 1935-36.

Biometrical work

As a considerable amount of variation in colour and body proportions was observable among the non-gregarious type of locusts met with in the desert breeding grounds, the locust collections made during the different seasons during the last five years are being subjected to a biometrical study. The elytron-femur ratios are being recorded for each specimen examined, and various other characters such as the colour of the wings, the number of eye-stripes and the general coloration are also being noted. The results will be studied in correlation with the general ecological conditions under which the broods of different years have been produced.

Study of old records

The locust movements recorded in the data collected from various sources have been mapped for the years 1926 to 1930 and are under study.

As far as possible, the direction of flights of swarms, as well as the general movements and activities of locusts during the years 1926-31, were correlated with the meteorological data available in the India Daily Weather Reports for these years. It has been found, in general, that the extent and intensity of locust breeding have been in direct proportion to the distribution and quantity of rainfall received. It is also evident that generally the direction of swarm movements is coincident with the direction of the winds prevalent at the time.

In regard to the causes of migration, the data available would appear to show that the ultimate factor that causes locusts to leave the places where they have recently bred and multiplied is, in general, the seasonal development of excessively unsuitable conditions of air-dryness and high temperature. In their endeavour to flee from such unfavourable conditions, locusts rise into the air, and are thereafter guided in their flights by the prevalent direction of the wind, which might in many cases take them ultimately into a climatically different belt.

The Fourth International Locust Conference

The Fourth International Locust Conference met in April, 1936, at Cairo in response to an invitation by the Egyptian Government to various countries interested in locust research, and was attended by sixty-three delegates sent by twenty-five different countries, including the United States of America, Canada, Arabia, Iran and Iraq, which were represented at the Conference for the first time. India was represented by Khan Bahadur M. Afzal Husain, M.A., I.A.S., Punjab Government Entomologist, who contributed two papers to the Conference and also presented two others submitted by the Locust Research Entomologist, Karachi. The discussions at the Conference were of great interest and practical value.

(*b*) **Other Insect Pests.**—***Sugarcane.*** At Pusa regular observations were taken every month on the incidence of major insect pests, *viz.*, borers, Pyrilla and termites, on spring plantings in a randomized experimental plot, and on the October and ratoon crops.

At the time of harvest in March 1936 about 2,500 canes (eight replications) of each of the five varieties Co 210, Co 213, Co 299, Co 313 and Co 331 were examined for borers and termites. The juices of the affected canes were chemically analysed. The data thus collected are being examined statistically and the results will be published soon. The incidence of the pests at the time of the harvest is summarized below :—

Variety of cane	No. of plants examined	Affected by top-borer	Affected by stem-borer	Affected by root-borer	Affected by termites
		Per cent	Per cent	Per cent	Per cent
Co 210 . . .	2738	51·169	22·50	36·27	7·34
Co 213 . . .	2774	35·87	33·17	29·89	5·52
Co 299 . . .	2786	37·19	13·10	26·27	0·68
Co 313 . . .	2136	40·50	41·25	46·40	3·61
Co 331 . . .	2017	26·13	18·64	32·15	2·63

The data collected during March 1935 harvest on the damage by borers and termites to Co 331 have been examined statistically. The following are the main conclusions :—

(i) The stem-borer causes comparatively the most amount of damage both in regard to the quality and quantity of the crop. (ii) The top-borer is next in importance to the stem-borer. (iii) Root-borer in the early stage of the attack is harmful but afterwards it is in no way detrimental to the crop either in tonnage or quality of the juice. (iv) The loss sustained by the attack of termites is variable.

Parasites and Predators of Pyrilla. Tetrastichus pyrillae and *Ooencyrtus pyrillae* were first seen in the field at Pusa in the third

week of July. In the experimental plot the parasitisation was twenty-two per cent in August but rapidly increased afterwards to 83·6 per cent of exposed eggs and 61·1 per cent of eggs inside sheathing leaves.

The Dryinid parasites of *Pyrilla* nymphs, *viz.*, *Dryinus pyrillae* and *Chlorodryinus pallidus* were found first in the field in the beginning of September. The parasitisation varied from one to three per cent during the year.

The eggs of *Pyrilla* were preyed upon by a neuropterous predator *Coniopteryx pusana.* It appeared in the field in the last week of July.

Parasites of borers. Apantales flavipes, a parasite of the stem borers *Diatraea sticticraspis* and *Diatraea venosata*, reported for the first time last year, was found in the field from January but not in such large numbers as last year. From fifteen to eighty *Apantles* grubs developed from each host larva. Three to five per cent of the larvae were found parasitised. *Rhaconotus scirpophagae*, a parasite of the top-borer, was first seen in the field in December. The parasitisation was low (about two per cent). *Phanurus* sp., a chalcid egg parasite of the top-borer was active from March onwards till winter months. The parasitisation ranged from three to fifteen per cent.

In ASSAM both top-and stem-borers were very bad on the Jorhat farm. All plants showing dead-hearts were removed and destroyed and elephant grass as a trap-crop was found useful. Top shoot-borer moths were more attracted than stem-borer moths. Braconid parasites from stem-borers and top-borers were released in the field. White-ant damage, which was severe in October plantation apparently due to dry weather, was kept in check by the use of crude-oil emulsion as a deterrent.

At Muzaffarnagar in the UNITED PROVINCES the stem-borer was active from May to September and destroyed twenty to thirty per cent of the tillers. The incidence of top-borer was twenty to twenty-five in September. Apart from the loss in tonnage, the borer attack entailed a loss of one per cent in sucrose and a reduction of three and a half per cent purity. The data about the

differential infestation of cane varieties showed significant resistance to the attack of various borers in certain varieties, but an ideal cane showing maximum resistance to all types of pest attack has not yet been discovered. Evidence was obtained that the application of phosphorus and potash as manures tended to minimize borer infestation, while abundant irrigation during the hot weather significantly decreased stem-borer attack. Water-logging was again found to increase the attack of borers and white fly.

Investigations of the seasonal behaviour of the major pests of cane showed that the pests rely mainly upon the young shoots from the stubble or ' stand ' cane during March and April for producing the first spring brood and that from these shoots the infection of the new crop subsequently takes place.

In the PUNJAB the study of sugarcane borers was continued at the Jullundur, Risalewala and Karnal farms. The attack of top-borer ranged from 2·9 per cent in the *barani* area to five to twelve per cent in the irrigated tract. The incidence of stem-borer, however, was ten per cent in the *barani* area and six per cent in the irrigated tracts. Observations on the varietal susceptibilities of Coimbatore canes to the attack of top-borer showed that Co 312, 313, 301, 243 and 270 suffered more heavily than Co 356, 391 and 395. Observations on *Pyrilla* showed that the pest laid more eggs on broad-leaved and succulent varieties of sugarcane than on narrow-leaved and non-succulent leaves. *Pyrilloxenos compactus* Pierce was found parasitising eighty to one hundred per cent Pyrilla. Other factors that brought about a reduction in the population of Pyrilla were hot winds during May and June, reduction in the food-stuff owing to the drying up of leaves during the ripening of canes and burning of ratoon canes. The black bug of sugarcane, *Macropes excavatus*, was found in larger numbers and it is feared that it may become a major pest.

In MYSORE special attention was devoted to the control of stem-borer in the Irwin canal area. Demonstration of light earthing up of cane when the crop is four to six weeks was done on an intensive scale. An area of 1,900 acres was protected through departmental

agency. The control of stem-borer by releasing *Trichogramma* on a large scale has been reported to yield encouraging results.

In the MADRAS Presidency, the most important pests of sugarcane were the top-borers *Scirpophaga auriflua* and *Scirpophaga monostigma* and stem-borers *Diatraea sticticraspis* and *Diatraea venosata*. Particular attention was paid to the seasonal incidence of these pests and their parasites.

In BURMA, *Alissonotum impressicolle* was again serious especially in the Sahmaw estate at Namti. Ratooning seems to help the spread of this pest. The occurrence of woolly aphis, *Oregma lanigera*, seemed to have some connection with soil acidity. Drastic action of burning all the infected plants prevented the spread of this pest.

Cotton. The control of Pink Boll-worm, *Platyedra gossypiella*, on a field scale received considerable attention in the UNITED PROVINCES. About 47,100 acres were sown with treated seed as compared to 45,000 acres last year. The seed was exposed to sun in hot days in April and May in order to kill the hibernating worms within. Owing to unfavourable weather in the beginning of the season and early cessation of rains, the Pink Boll-worm damage in uncontrolled areas was below normal. Nevertheless the difference in yield and quality of cotton in the treated and untreated areas was very significant. Such increased value of crop on account of extra yield *plus* premium due to better quality is estimated at Rs. 21 to 27 per acre. A bill for the control of cotton pests was introduced in the Legislative Council, and passed.

In the PUNJAB, the black-headed crickets (Gryllids) and surface grass-hoppers were reported damaging cotton seedlings at several places. Baiting with bran poisoned with sodium fluosilicate proved useful. The cotton semi-looper (*Tarache notabilis*) and hairy caterpillars (*Euproctes* spp.) were reported from Lyallpur and were controlled by poison bran-baits and hand-picking. The staff for the Spotted Boll-worm scheme financed by the Indian Central Cotton Committee was chiefly engaged on an extensive survey of the host plants of Spotted Boll-worm, particularly during the off-season of cotton. It was found that it was mostly on sprouted cotton that the pest survived during the off-season. A clean-up campaign is

being organised. In the south-eastern, central and sub-mountainous regions of the province, other host-plants in addition to cotton have been discovered, particularly *Malva parviflora*, *Abutilon indicum* and *Malvestrum tricuspidatum*, which must be simultaneously dealt with in a clean-up campaign. Biology of a number of larval and pupal parasites has been studied but no really effective parasite has yet been found. The Spotted Boll-worm, unlike the Pink Boll-worm, is more severe in the Canal Colonies and in the Western Punjab than elsewhere. From the results of the night-caging experiments, the loss due to this pest is estimated at twenty-six per cent in *desi* cotton and ten per cent in 4 F against sixty-five per cent and forty-seven per cent respectively last year. Of the three species of *Earias*, viz., *insulana*, *fabia* and *cupreoviridis*, met with in the Punjab, only the first two are pests, the first being by far the commonest. *Insulana* is seen feeding on all host-plants so far known in the Punjab, while *fabia* is observed only on *Hibiscus esculentus* and rarely on other plants. Both *insulana* and *fabia* remain active throughout the year, while *cupreoviridis* hibernates in the pupa form from October to April.

A further study of the incidence of the cotton White Fly, *Bemesia gossypiperda*, in relation to fertilizers has shown that the soil treated with ferrous sulphate at the rate of ten maunds per acre had the lowest average incidence. The most active period of the fly is from May to September after which it migrates from cotton to alternative host-plants such as *Brassicae*, *Solanum tuberosum*, *Lycopersicum esculentum* and various weeds, on which it passes winter. From March to May it spreads to cucurbits and ratoon cotton, and thereafter to new cotton where it establishes itself again. Infestation was found higher again this year on Mollisoni than on the Punjab-American types and was reduced to some extent when ammonium sulphate was applied to the crop early in the season. The chemical analysis of the affected and unaffected plants shows little difference in their nitrogen-content till about the second week of July. Thereafter till the end of August the unaffected plants contained more nitrogen than the affected ones. The total quantity of nitrogen produced in a season in an unaffected plant amounts

to an average of 1·20 grams against 0·95 grams in an affected plant. The percentage of nitrogen transported from the vegetative to reproductive organs of the affected and unaffected plants is estimated at twelve and twenty respectively.

Research work on the boll-worms of cotton in the CENTRAL PROVINCES and BERAR financed by the Indian Central Cotton Committee has shown that in the Central Provinces the Spotted Boll-worm only constitutes a pest of importance, the damage by the Pink Boll-worm being insignificant. During February to June, the boll-worms survive on cotton sprouts and other malvaceous plants and thus the control is the same as that recommended in Bombay and Gujarat, *viz.*, uprooting of cotton sticks and stubble and eradication of alternative host-plants as early as possible after the harvest of the crop. The damage to cotton done by the gram caterpillar (*Heliothus obsoleta*), hitherto unknown as a cotton pest in India, has been found to be as serious as that caused by boll-worms. Like the Spotted Boll-worms, it first bores into the tender shoots and later on buds and young bolls are damaged. It continues damaging cotton till about the end of October when bud formation is at its height and it disappears thereafter temporarily till November, when it again appears on the gram crop.

As a result of the work on boll-worms carried out in the HYDERABAD State, it is estimated that the loss in yield of the cotton crop due to this pest is about fifteen per cent and amounts to about fifty lakhs of rupees every year. The life-histories and methods of carry-over of the pests from season to season and their alternative host-plants have been studied.

The plant-puller propaganda in Surat and Broach districts of the Bombay Presidency was continued. The clean-up campaign clearly demonstrated that by removing the cotton sticks and stubble in time the cultivator will receive twenty-five to thirty per cent more yield. During the year 739 plant-pullers were sold in Surat district and 2,271 in Broach district. The area uprooted was 56,000 acres or twenty per cent of the total cotton area in Surat and 143,296 acres or sixty-two per cent of the total area in Broach

district. Similar clean-up scheme was started in BARODA in January 1936 to control the cotton boll-worms.

In the MADRAS Presidency, the relative percentage of infestation of the boll-worms (*Platyedra* and *Earias* spp.) in the Cambodia, Uppam and Karunganni varieties was studied weekly at the Central Farm at Coimbatore. Experiments were devised to study the attraction of certain chemical substances to the Pink Boll-worm moths, but the results were negative in all the cases. Blue and green coloured lights had also no attraction for them. Attempts to rear *Microbracon Lefroyi*—a parasite of the Pink Boll-worm—did not succeed though the larvae were stung and paralysed by the parasite.

A scheme, financed by the Indian Central Cotton Committee, was started to devise control measures against the cotton stem-weevil (*Pempheres affinis*), which is a serious pest in all the Tamil districts in South India. It was found that the incidence of the pest varied in inverse proportion to the length of the close period between the two cotton crops. Moreover cotton grown under drier conditions seemed to suffer less than that receiving irrigation or intermittent rainfall during its growth. Counts taken of the weevil in January at the Central Farm showed that Cambodia, Uppam and Karunganni had fifty-two per cent, 9·8 per cent, 0·6 per cent infestation respectively. During the survey of the pest, four species of parasites, a braconid and three chalcids, were found parasitising the grubs of the weevil, but no parasite has so far been found on the egg, pupa or adult. The four parasites put together did not account for more than five per cent of the mortality of the host larvae, but under favourable conditions the braconid might give better results.

In BURMA, the stem-weevil (*Pempheres affinis*) was again found this year on cotton at Mahlaing.

Paddy. In ASSAM *Spodoptera mauritia* and *Prodenia litura* did appreciable damage soon after the floods. The rice case-worm, *Nymphula depuctalis*, did serious damage in certain districts but disappeared with the drying up of fields. The rice-bug, *Leptocorisa varicornis*, did considerable damage to paddy in Sylhet. In some

case 96·7 per cent of grains were affected. Bagging was found to be a fairly effective control measure. The rice hispa, *Hispa armigera*, was also a bad pest. Observations made on the latter pest show that, weather conditions being favourable, the early attacks have no perceptible bad effect on the outturn, but if the infestation is late in the season, the loss is found to be great.

In BENGAL, the rice swarming caterpillar did considerable damage in many districts. Rice hispa appeared in Dacca district and was controlled by bagging.

In TRAVANCORE, the paddy swarming caterpillar did considerable damage. Dusting with Paris Green was found to be effective. The paddy stem-borer was kept in control by an energetic campaign organized to weed out from the nursery all infested seedlings.

In the MADRAS Presidency, an intensive study of the paddy stem-borer *Schoenobius incertellus* was carried out throughout the year. The late maturing as well as the second crop showed invariably a heavier percentage of attack and no variety was found to be completely resistant. Light-trap trials carried on at the Central Farm at Coimbatore showed a marked decrease in damage over the untreated control plots and further revealed that the range of efficiency of a 200-candle power light is only a radius of 350 yards as estimated by a count of white ears. From a study of the life-history of the pest in the insectory on potted plants, it was noticed that the insect's best season of activity was during periods of moist warm weather with plenty of standing water in the crops. The life-history of the paddy swarming caterpillar *Spodoptera mauritia* was continued for six broods. The year's observations suggested that the micro-climatic conditions have a strong and profound influence in attracting a large influx of moths in the area within three or four days of sowing and germination of the crop.

In BURMA, *Hispa armigera*, *Ripersia sacchari oryzae* and *Cirphis unipuncta* were reported damaging rice in several places.

Tea. The work on insect pests of tea was continued in the Tea Scientific Department of the United Planters' Association, South India. Termites, bark-eating borers, nettle grubs, looper caterpillars and scale insects were prominent tea pests reported. The

life-history and various factors influencing the incidence of *Helopeltis* in South Travancore were studied. Some preliminary spraying experiments were performed to control the pest and it was found that one per cent strength of Nictagral C. and 0·5 per cent strength of Niconone were effective but were too costly. In addition to the parasites of nettle grubs reported during the previous years, four parasites *viz.*, *Buysmannia* sp. (Ich.) and *Goryphus* sp. (Ich.) attacking *Spatulifibria grisea*, *Euplectrus* sp. attacking *Narosa conspersa* and *Formicia ceylonia* (Braconid) attacking *Thosea cervina* have been observed. *Canthecona furcellata* Wolff was noted to be a common predator on *Thosea cervina* in South Travancore.

In addition to *Coptotermes* sp. previously reported, a new species of *Calotermes* was found attacking living tea bushes in South India.

The coccinellid *Chilomenes 6-maculata*, three species of Syrphids (*Paragus atratus* de Meij, *Paragus serratus* F. and *Syrphus aldigatus* Wied.) and an unidentified Hemerobiid have been noted to prey on the tea aphis *Toxoptera aurantii* Boyer. Nictagral C. (0·25 per cent) was tried against aphids with good results, but the cost of the spray was much more than that of tobacco decoction which gave almost equally good results.

The occurrence of the shot-hole borer (*Xyleborus fornicatus*) on tea in Central Travancore has been confirmed.

An outbreak of *Ectropis bhurmitra* Warr. caused serious damage to tea in South India. This pest was active from October to December. Its life-history was worked out. *Grevilleas* and *Gliricidias* were noticed to be alternate hosts of this pest. Lead chromate has been tried with success against this pest when confined to a small area. Systematic collection and destruction of caterpillars in early stage of the outbreak and of pupae and moths has been recommended.

Some tea fields were badly infested with the bark-eating borer (*Indarbela* sp.). Weak bushes were preferred to new ones.

Lecanium hemisphaericum Targ., commonly found on coffee, also occurred as a pest of tea bushes in Travancore. Spraying with fish oil resin soap at a strength of two lbs. to a kerosine tin of water was found effective.

In addition to *Thrips florum* Schm. and *Heliothrips haemorboidalis* Bovele, four more species of thrips, *viz.*, *Scirtothrips* sp. *Scirtothrips dorsalis* Hood., *Thrips* sp. and *Neobeegeria* sp. and *Ereboenis saturata* Meyr., were noted on tea bushes in South Travancore.

Ereboenis saturata (Pyralidae) was found to occur in both Central and South Travancore.

Tobacco. The work on insect vectors of leaf-curl of tobacco was continued at PUSA. Transmission experiments have shown that the virus responsible for the leaf-curl in sann-hemp is the same as that causing the disease in tobacco and that the white fly (*Bemisia gossypiperda*) is a transmitter from sann-hemp to tobacco.

Aphids and *Chloridea obsoleta* Fb. occurred on tobacco at Pusa and the former were successfuly controlled by spraying with nicotine sulphate.

Coffee. The use of coal tar distillate emulsion against the coffee stem-borer having been found fairly effective in MYSORE, the tar distillate test for borer control was repeated on a more extensive scale at Coorg.

Honge oil resin soap has been tried with success to control the green bug in South India. Some preliminary experiments were performed to find out a combined spray for both the green bug and fungus diseases of the leaf. A mineral-oil emulsion which is miscible with Bordeaux mixture seems to be promising.

Linseed. Further investigations with reference to the incidence of the linseed fly (*Dasyneura lini*) on various varieties of linseed were made at PUSA. The pest was found infesting the early flowering variety in the second half of January and the middle flowering variety in the first three weeks of February. The late-flowering varieties suffered the most from this pest. How and on what plants the pest passes the rest of the year is still under investigation. It is of interest to note that *Cajanus indicus* at Pusa was also found being damaged by this or a very closely allied species during February and it is not improbable that *Cajanus indicus* is an alternate host of the pest.

Agrotis ypsilon occurred in linseed at Pusa and was kept in check by hand-picking.

Laphygma exigua was reported to occur on linseed at Mahlaing and Mandalay (BURMA).

Vegetables. At PUSA it was observed that *Plusia* spp., *Chloridea obsoleta* Fb., *Prodenia litura* Fb., *Diacrisia obliqua* Wlk., which were breeding on vegetable crops during the winter, passed to and bred on berseem and lucerne in the spring when the vegetable crops had been harvested.

The parasites were reared from the following pests of vegetables :—

(1) Tachinid parasites from the larvae of *Diacrisia obliqua* Wlk., *Plusia orichalcea* Fb., *Chloridea obsoleta* Fb., *Agrotis ypsilon* Rott., *Crocidolomia binotalis* Zell.

(2) Braconid parasites from *Polyommatus boeticus* Linn. *Hellula undalis* Fb., *Diacrisia obliqua* Wlk., *Plusia orichalcea* Fb.

(3) *Ichneumonid* parasites from *Chloridea obsoleta* Fb.

In the PUNJAB, the life-history of *Epilachna* beetle was studied. A female was found able to live for fifteen months and it laid 783 eggs. This period occupied two active seasons of the pest. Onion thrips (*Thrips tobacii* Lind.) did a lot of damage to the onion crop in most parts of the Punjab. Spraying with resin soap gave a mortality of ninety-seven per cent. The cost of spraying was Rs. 16 per acre and this is about one-eighth of what an onion crop fetches. *Tindas* (H.) were badly attacked by the mite *Tetranychus telarias* L. which multiplied very rapidly. Dusting with lime sulphur (1 : 5) gave good results.

In the CENTRAL PROVINCES, chilly plants suffer from a virus disease of which aphids seem to be the vectors. The affected plants were sprayed with nicotine sulphate and soap.

In TRAVANCORE, yams and other ' roots ' preserved for planting generally get heavily infested by a minute scale. If such roots are planted, they fail to sprout or develop into very weak plants. It was found that infestation may be prevented by coating the yams with cow-dung paste soon after they are dug out. The sweet potato, a very important crop in the area, was attacked by the black weevil which riddles the tubers when they are in fields. Observations

indicate that the varieties known as Kumbala Vella and Kumbala Chovala were more resistant.

At the Agricultural College, POONA, it was established by further experiments that virus-free thrips on healthy chilly plants did not cause the characteristic curling and mottling of leaves which was produced by virus-affected thrips. Spraying experiments with a home-made nicotine extract gave a ninety-seven per cent kill which is as high as obtained with Black Leaf 40.

At COIMBATORE, in the Madras Presidency, *Laphygma*, *Prodenia*, *Chrotogonus* and *Ophideres* spp. infesting tomatoes were studied. *Laphygma* in nurseries was kept in check by dusting calcium arsenate. *Prodenia* attacked both leaves and fruits and was checked by systematic hand-picking of caterpillars. The fruit-sucking moths *Ophideres materna* and *O. fullonica* were very serious on tomato fruits. The former predominated. The most effective control was by bringing suddenly a bright light near the moths at the time of feeding which stupefied them. As the moths were then unable to fly, they were hand-picked easily and destroyed; thus hundreds of moths were destroyed. *Plutella maculipennis* was severe on cabbage and was effectively controlled by Derris-root powder. A fairly effective chalcid parasite of these caterpillars was also noticed and studied.

Fruits. At the request of Mr. M. B. Gurney, Entomologist, New South Wales, who visited Pusa in the course of his travels in search of suitable parasites of fruit flies for introduction into his country, *Opius fletcheri*, an important parasite of fruit flies, was studied in detail at PUSA. It was found that the most common host of the parasite is the fruit fly, *Chaetodacus cucurbitae*, which breeds in large numbers in fruits of *gheura* (H.) and *Jhengni* (H.) (*Luffa* spp.). The appearance of *Opius fletcheri* in the field begins in the third week of September. The temperature between 70° and 77°F. is most favourable for the development of the parasite. A constant temperature of 95°F. is lethal for both the host and its parasite. The percentage parasitization of the larvae and pupae of the fruit fly reached the highest figure of twenty in October.

In ASSAM, scale insects on citrus trees were successfully controlled by crude oil emulsion and resin wash. The citrus trunk-borer *Monohammus versteegi* and mites on litchi leaves were also bad.

At the experimental orchard at Chaubattia in the UNITED PROVINCES, some further work was done on the apple root-borer, *Lophosternus hugeli* and woolly aphis. The average attack by the former was over six per cent, rising to twenty per cent in serious cases. The woolly aphis damaged twenty-two per cent of the trees. While spraying operations killed the shoot form of this aphis, the root colonies underground remained unaffected and acted as a source of infection. It is surmised that the failure of *Aphelinus mali* to establish itself in the Kumaon hills may be due to their starvation consequent upon the destruction of shoot colonies by lady bird beetles and syrphid flies.

In the PUNJAB, investigations on the bionomics and control of walnut weevil were continued. The bionomics and alternative host plants of the woolly aphis were under investigation in the Kulu valley. It was observed that in May the aphis completed a life-cycle in eight to thirteen days, whereas in winter it took ninety to ninety-three days. The large increase of this pest in summer was chiefly due to its parthenogenetic multiplication. Spraying with resin compound containing creosote oil, creosote, solignum and tobacco dust gave satisfactory results. Soil treatment with para-dichlorobenzene or sanitary fluid gave cent per cent kill of the root forms. Winter sprayings against San Jose Scale were carried out in Simla on about thirty-four thousand trees. Effective control measures were carried out against lemon butterflies, white fly of citrus, mango hoppers and termites infesting fruit trees.

In BALUCHISTAN, the Codling moth and *Spilonota ocellana* were observed doing serious damage to apples at certain localities. The life-history of these pests as well as of the black peach aphis (*Lachnus persicae*), and shot-hole borer (*Scolytus amygdali*) have been investigated to some extent.

In the CENTRAL PROVINCES, carbon bisulphide was given further trials with a great measure of success for the control of the borer *Indarbela* sp. of orange trees.

In MYSORE State water suspension of *Mundulea suberosa* stem bark, *Tephrosia candida* seed, *Clerodendron inermii* stem and *Citrullus colocynthis* stem at twenty per cent strength were found effective against mango hoppers.

Of the many parasites attacking caterpillars of *Nephantis serinopa* (the coconut leaf-roller) in TRAVANCORE State, some *Eulophids* were found most promising.

In the MADRAS Presidency, the bionomics of the Coccinia fly *Dacus brevistylus* was studied in detail. *Dacus ferrugineus incisus*, infesting mango, guava, tomato, orange, plum, etc., was found breeding in berries of *Solanum verbascifolium*, a wild solanum in the Nilgiris. The control of fruit flies by poison baits and parasites received attention.

In BURMA, a simple band greased with a substance consisting of 2¼ lbs. resin and one pint castor oil heated but not boiled to dissolve the resin proved very satisfactory as a sticky band against various crawling insects. Injections of carbon bisulphide proved effective against longicorn borers in mulberry stems. A new species of a bark-boring beetle, *Agrilus citri* Chery, was recorded on citrus from Mandalay.

Stored grain pests. At PUSA, ecological studies on the biology of the common rice-weevil, *Calandra oryzae*, were continued. It was found that at and above ninety-five per cent relative humidity the weevils did not lay eggs at all, at about seventy-five per cent relative humidity the breeding was quite active, but below fifty per cent relative humidity all the weevils died within three or four days without feeding and laying eggs. The duration of the various stages in the life-history of *Calandra oryzae* were worked out, and the parasite *Aplastormorpha calandrae* feeding upon the grubs and pupae of the weevil was bred.

In ASSAM carbon bisulphide and para-dichlorobenzene proved very effective fumigants against *Calandra oryzae*. Short exposures

(thirty to thirty-six hours) had no bad effect on germination activity of the fumigated grains.

In the PUNJAB it was observed that infested grains stored with free mercury were not further attacked by the pest.

In MYSORE *Bruchus chinensis* was dusted with various dusting powders made from indigenous plants, and it was found that the powder of the seeds of *Tephrosia candida* and of the stem "Chrimulla" were found to be very toxic causing one hundred per cent mortality by contact action. The powders of the fresh bark of *Mundulea suberosa* and the seeds of *Anona reticulata* were also toxic, but took a little longer time to act.

In the MADRAS Presidency the relative incidences of *Rhizopertha dominica* and *Calandra oryzae* in different varieties of paddy and *cholam* respectively were studied. The bionomics of *Bruchus analis* was also worked out.

In BURMA the study of the pulse beetles on sixty-five different varieties of peas and beans was continued. *Bruchus chinensis* L. *Bruchus analis* F., *Bruchus phaseoli* Gyll. were found to occur both in the field and in store, but *Bruchus albocallosus* Pic. was found to be present in the fields only. Attempts were made to discover a strain of *Cajanus indicus* (pigeon pea) resistant to *Bruchus chinensis*. About ninety-seven different strains of pigeon peas were grown, and some degree of resistance was observed in some strains.

7. Useful Insects

Apiculture. This cottage industry showed signs of becoming popular in some parts of India. The Imperial Entomologist supplied standard hives, comb foundation sheets and other bee appliances and gave advice on modern lines of bee-keeping to numerous correspondents from several provinces. The Departments of Agriculture in the Punjab and Madras maintained several apiaries and gave demonstrations to the public in their respective areas.

Laccifer lacca, Kerr. (***Tachardia lacca.*** Kerr.) Coccidae: Research work at the Indian Lac Research Institute at Namkum

has resulted in the following important advances in the entomology and chemistry of lac and shellac during 1935-36.

Investigation of lac-hosts of minor importance gave the following interesting results. During the *Baisakhi* (October-June) crop, good yields were obtained from *Ougeinia dalbergioides*, *Albizzia lucida*, and *Flemengia congesta* infected with *Palas* (*Butea frondosa*) brood. During the *Aghani* crop, good yields were obtained from *Dalbergia latifolia*, *Albizzia lucida* and to a less extent *Ougeinia dalbergioides* infected with *kusum* (*Schleichera trijuga*) brood. It was further shown that *Acacia catechu* (*Khair*) is a good *Katki* (rains) host infected with either *Palas* or *ber* (*Zizyphus jujuba*) brood.

A systematic study is being continued of the mortality, fertility, resistance to insect enemies, yields, etc., obtained from different strains of lac when grown on various lac-hosts, not only at Namkum, but in other important districts in the major lac-growing area. These results have enabled the Institute to give advice to cultivators in various districts as to what hosts and which strains of lac are most likely to be satisfactory in their district.

Zizyphus jujuba (*Ber*), an improtant lac-host, has the failing that in hot arid districts it will not carry *Baisakhi* lac through the hot weather to give brood lac in July. A method is being tested and is giving very promising results for overcoming this failing by partial light pruning of infected *ber* trees prior to the hot weather to do away with the resting period, and to induce rise of sap during the hot weather months.

The study previously reported on the myology of the adult female lac insect and of the mechanism of swarming has led to the development of a simple method for forecasting the date of emergence of larvae. Forecast of emergence is carried out by the Institute for cultivators on request.

Further research has shown that *L. lacca* females can reproduce parthenogenetically for as many as fourteen successive generations without detriment to their fertility, the sex ratio or the resin-producing capacity of their progeny. Females of *L. lacca* are deatero-

tokons, the unfertilised female producing young, some of which are male and some female.

As result of the study of the two major enemies of lac, *Eublemma amabilis* and *Holcocera pulverea*, both of which are predatory on lac, and of the minor enemies, the parasites, of which eight species belonging to the *Chalcidoidea* commonly occur, simple control methods have been devised. Directions for control methods against these enemies for the ryots' use have been drawn up and published during the year in pamphlet form, in English, Hindi and Bengali. The methods described are of extreme simplicity and entail no expenditure; they may be classed largley as control by cultural practice.

Research work in connection with the predators which are the major enemies of lac, and on their natural enemies have shown that out of the large number of natural enemies under investigation three are likely to prove of importance in biological control.

Among indigenous enemies, *Microbracon greeni*, parasitic on *Eublemma amabilis*, has given the most interesting results. It can readily be bred in the laboratory and the year's results confirm the conclusion that the purposeful introduction of laboratory-bred adults at critical times would be beneficial. A second indigenous parasite *Apanteles tachardiae*, parasitic on *Holcocera pulverea*, has been under special review. So far, it has been impossible to breed *A. tachardiae* in the laboratory, but a technique has now been devised by which this difficulty is being overcome and it is hoped to perfect this in the coming year.

Microbracon hebetor, a parasite of *Ephestia kühniella* introduced from Ceylon, utilised at Namkum as an ectoparasite of both lac-predators *E. amabilis* and *H. pulverea*, is now breeding satisfactorily in the laboratory on these two lac-predators. A number of alternative hosts have been discovered, all of which are pests, including the Pink Boll-worm of cotton *Platyedra gossypiella*. During the year, laboratory-bred adults have been liberated in specially chosen restricted areas, and colonisation shown to have occurred. The year's results clearly indicate that *M. hebetor* is becoming acclimatised to *E. amabilis* and *H. pulverea* as hosts

and is able to breed on them under plantation conditions. This work will be carried further in the ensuing year.

Host-tree pests have not been active during the year. *Termites* have been the only important pests and systematic fumigation of termitaria has held them in check.

A number of interesting *Chaldidoid* parasites were bred from the host pest *Aspidiotus orientalis*. These included *Aphytis chrysomphali*, *Comperiella bifasciata* and *Physcus* sp. (near *flaviventris*). The two lac-parasites, *Tetrastichus purpureus* and *Mariella javensis*, were both bred as secondary parasites of *A. orientalis*.

The training of *kamdars* (farm-trained men for propaganda) has been taken in hand. Three *kamdars* have already been trained. These men were sent out at the infection and cutting seasons and demonstrated to the ryots improved methods of infection, crop reaping and pruning, and also gave talks on simple means of pest-control. At other seasons they were at Namkum in order to keep in touch with the work being done at the Institute. More *kamdars* are at present undergoing training.

The deterioration of shellac due to certain harmful practices during manufacture was investigated. The use of mineral acids for lightening the colour and for recovery of lac from the by-products of manufacture, for re-use in subsequent batches, was found to be responsible for insolubilising the shellac and rendering its filtration from alcoholic solutions difficult.

The role of nitrogenous impurities and various factors influencing the bleaching of lac were investigated.

Analyses of a large number of commercial grades of lac showed the points of similarity and difference as regards their suitability for various industries.

Further work was done on the utilisation of lac in the plastic moulding and varnish industries. The use of urea in the former and of a combination of plasticisers and accelerators in the latter, were investigated. Cold hardening of shellac in acetone solution was studied. Preliminary experiments were conducted on the use of a shellac adhesive for cementing plywood and micanite. Isolation of the hard resin in shellac by a new method depending

upon urea, and modification of lac by polycarboxy acids were carried out.

8. Sericulture

Sericulture in India is concerned with several kinds of silk-worms with different foods and habits. What is commonly known as silk (*resham*, *garad* or *pat*) is obtained from worms which feed on mulberry leaf and are wholly domesticated and reared indoors. Sericulture mainly refers to the rearing of these worms. *Tasar* and *Muga* are produced by worms which are wild in nature and have to be left to feed at will on their food trees in the open, mostly in forest areas. *Eri* silk-worms feed on castor-leaves and are domesticated like the mulberry-feeding ones. Sericulture is the first stage of the silk industry, the two succeeding stages being reeling of raw silk from the cocoons or spinning in the case of unreelable cocoons such as *Eri* and manufacturing of fabrics from the raw or spun silk. As the hereditary and fatal pebrine disease of the worms can be kept under control only by rearing the eggs of moths free from disease, microscopic examination of the body-juice of mother moths is necessary for successful sericulture. Also the contagious nature of this and other diseases calls for disinfection of rearing houses and appliances. The problems of sericulture are finding out and adopting (1) the best and suitable varieties of mulberry and the best and cheapest method of growing them, (2) high-yielding races of worms, (3) proper organisation for production and supply of disease-free seed (eggs and seed-cocoons) and (4) sanitary methods of rearing. Organisation of reeling becomes a necessity as otherwise the cocoons produced cannot be utilised.

Continued depression in the silk trade, low prices of raw silk and abnormal competition with cheap imported raw and spun silks affected the sericultural industry adversely in all places, leading to contraction of reeling and necessarily of rearing. Although on the recommendation of the Indian Tariff Board a protective tariff was imposed, the industry was not reported to have benefited appreciably. The monetary help rendered by the Government of India to several provinces and states for the improvement of the industry

was utilised during the year, as will appear from the activities reviewed below.

BENGAL. The Sericultural Department was transferred to the Department of Industries from the Department of Agriculture.

Financial help from the Government of India. The following grants were received from the Government of India on the recommendation of the first meeting of the Imperial Sericultural Committee, *viz.*, for sericultural improvement, non-recurring Rs. 10,000 and recurring Rs. 36,924, and for investigation as to comparative suitability as disinfectants of formalin and bleaching powder, non-recurring Rs. 500 and recurring Rs. 2,000.

Mulberry. Unprecedented drought prevailing during the year affected mulberry. Sann-hemp and indigo grown as green manure among mulberry kept down weeds, thus bringing about a saving in weeding. In Piasbari nursery, rotten tank weeds (*bhode*) and silt from old tanks proved to be of good manurial value. Cow-dung and oil-cake and oil-cake and tank-silt proved satisfactory in different soil conditions.

For some years past growing of tree mulberries has been encouraged. Shoots growing from cuttings are allowed to grow and one-year-old saplings are planted out to grow into trees. A total of 13,170 saplings were distributed during the year to the rearers bringing up the total of trees to 52,442. The number of similar trees growing in different nurseries was 29,007.

Silkworm seed supply. Seven Government nurseries maintained mother stocks of suitable strains of the indigenous multivoltine Nistari and Chotopolu and the univoltine Baropolu silkworms and carried out a selection of the strains. Seed was produced and supplied to the selected seed-growers and also to rearers.

Prior to the inauguration of the scheme financed by the Government of India there had been 202 selected seed-growers who received seed from the nurseries and reared industrial seed for the ordinary rearers. The Government of India's grant enabled their number to be raised to 356 in October 1936 and simultaneous opening of twelve seed-examining centres in the silkworm-rearing districts, which received seed-cocoons from the nurseries and supplied cellu -

lar seed to the seed-growers, who in their turn produced and supplied industrial seed to the rearers. Between October and the end of the year, these centres examined 3,66,648 moths and supplied 2,86,453 selected cellular layings.

The total industrial seed-cocoons supplied to rearers during the year were 24,308 *kahons* (*kahon*=1,280) as against 18,437 during the previous year.

Demonstration and propaganda. The grant from the Government of India enabled the addition of eight inspectors and thirty-five demonstrators to be made to the existing staff of four inspectors and fifteen demonstrators.

This staff was engaged in the organisation of seed supply referred to above and in demonstration and propaganda among the rearers, in the course of which 234 rearing houses were improved, 839 rearing houses were disinfected, 239 out of 266 epidemics successfully controlled and a trial on the comparative efficiency of formalin and bleaching powder was undertaken in two batches of rearing houses numbering 188 treated with formalin and 194 treated with bleaching powder. This also involved a mass disinfection of surrounding houses numbering 3,442.

Sericultural training. The department maintained two schools attached to two nurseries and trained twelve students of whom ten came out successful in the final examination. The students received a stipend of Rs. 10 each per month.

Seven primary schools having 276 boys and sixty-one girls between them were helped with grants varying from Rs. 5 to Rs. 7 per month for arranging for instruction in sericultural methods.

Financial help to the industry. Agricultural loans granted to the rearers on the recommendation of the department amounted to Rs. 12,121 as against Rs. 9,440 during the preceding year.

Rs. 1,500 was given as free grants to six successful students of sericultural schools for building model rearing houses and carrying on work as selected seed-growers.

A loan of Rs. 25,000 was granted to a reeling concern under the State Aid to Industries Act.

Eri silk worm. This worm was reared only in Bogra district where there was a special demonstrator for helping the rearing of this worm and the spinning of the cocoons. During the year 127 families produced eighteen maunds of thread worth about Rs. 1,805.

Co-operation. The Sericultural Department supervised sixty-four societies under the Malda Central Bank and thirty-two societies under the Malda Co-operative Silk Union.

MYSORE. The mulberry area in Mysore decreased during the year from 30,000 acres to 28,500 acres. New plantations were, however, undertaken in some places. The Government sanctioned a scheme of paying a bonus for mulberry *topes.* About 1,500 saplings for trees and about twenty cartloads of cuttings were supplied to sericulturists free of cost.

Seed supply.—(*a*) *Government grainages.*—Two new Government grainages were added during the year to the seven already existing. Government also sanctioned additional grants and staff for better facilities for seed production and supply. The Government grainages prepared 3,849,512 disease-free layings and 2,686,501 pure foreign and cross-bred layings as against 3,249,512 and 2,099,824 layings respectively in the previous year.

For production of cross-bred layings, 74,503 pure foreign race layings were supplied free of cost to special selected rearers from whom the resultant seed-cocoons were bought by Government and aided grainages.

The cost of production of seed, excluding pay and travelling allowance of staff, amounted to Rs. 0-10-9 per one hundred layings as against Rs. 0-11-10 during the previous year.

The Government grainages supplied eggs to 11,500 rearers.

(*b*) *Aided grainages.* In view of the reduction of the price of eggs supplied from Government grainages to Rs. 0-8-0 per one hundred layings, the bonus to aided grainages was raised from Rs. 2-8-0 to Rs. 5 per 1,000 layings prepared and distributed.

Four new aided grainages were started during the year, raising their number to seventeen, of which two old ones did no work but were undertaking arrangements for production of cross-bred layings, there being hardly any demand for Mysore layings. The fifteen

aided grainages prepared 19,52,067 layings during the year as against 898,858 layings the previous year and supplied 1,934,922 layings to 3,171 rearers in 707 villages. There was a prospect of increase in the number of aided grainages as trained young men were coming forward to start and work them.

(*c*) *Selected seed-growers.* There were 502 selected seed-growers as against 465 the previous year, to whom 359,585 Mysore layings, as against 248,331 layings the previous year, were supplied free of cost and who put on the market about 600 lakhs of seed-cocoons as against 480 lakhs the previous year. These seed-cocoons were bought by Government and aided grainages, co-operative sericultural societies and private rearers.

The number of disease-free layings supplied from the institutions under the control of the Sericultural Department amounted to about fifty-nine lakhs as against forty-two lakhs in the previous year.

Research and experiments. The work already undertaken was continued on manures and manuring and budding and grafting of mulberry, on comparative merits of tree and bush mulberry and seedling and cutting plantations and on races of worms and hybridisation.

Experiments on the refrigeration of silkworm eggs, financed by a grant of Rs. 3,000 from the Government of India on the recommendation of the first meeting of the Imperial Sericultural Committee, were commenced in August 1935.

Use of groundnut oil-cake, in rotation with farmyard manure increased the yield of leaf to about 21,000 lbs. per acre from about 12,000 lbs. with farmyard manure alone. Seedling plantations showed an increase of about fifteen per cent over cutting plantations. As regards spacing, $2' \times 2'$ gave the highest yield.

Worms fed on leaves of trees and seedling plantations gave better results than those fed on leaves of bush and cutting plantations, and those fed on leaves of mulberry manured with groundnut oil-cake produced cocoons with higher silk-content and better denier and filament length.

Demonstration and propaganda. The staff constantly visited the houses of rearers and advised them on mulberry cultivation and rearing and also helped them in procuring eggs, bringing more than 27 lakhs of layings to their very doors.

Sericultural training. Thirty-six students were under training in the different Government sericultural farms of whom twenty-four completed their course. In the sericultural classes attached to Government Middle Schools, 227 students took sericulture as optional subject.

Sericultural co-operation.—Although there were twenty-one Sericultural Co-operative Societies on the list, only six worked during the year. This was due to depression in the trade and decrease in the area under mulberry. Their work consisted in production of disease-free layings for members and rearing the worms together in the first two or three stages (*chawki*).

Sericultural loans. Loans amounting to Rs. 1,350 were sanctioned to eleven persons during the year and the total disbursement including loans sanctioned in the previous year was Rs. 1,787.

Reeling. The Government Silk Filature worked twenty-four to twenty-nine basins and purchased 101,334 lbs. cross-bred and 3,720 lbs. Mysore cocoons. The rearers of cross-bred cocoons were thus helped with ready disposal of their produce. None of the Mysore Domestic Basins worked during the year. Ten volunteer students were trained in reeling in the Government Silk Filature.

Silk weaving. The silk weaving factory used the raw silk produced in the Government filature and in private filatures.

MADRAS. Drought affected the mulberry crop. Budding and grafting were carried out in the Conoor farm.

Seed supply. Hybridisation was continued in the Conoor farm which also supplied 17,600 seed-cocoons and 7,300 layings to the three other farms and 12,586 cross-bred layings to rearers. Hybridisation with imported races of worms from Japan being unsuccessful, arrangements were made for supply of foreign races of worms from the Director, International Committee at Shanghai for improvement of sericulture in China.

The three farms at Hosur, Palmaner and Thadaguni produced and supplied 177,402 layings. Arrangements were made for starting two aided grainages.

The Peripatetic Rearing Party was strengthened by the addition of nine moth-testers and the Kollegal taluk was divided into fifteen circles, each circle being placed in charge of a moth-tester. The party tested 1,102,049 layings as against 961,588 during the previous year. The private rearers availed of their services only about Rs. 248 worth of purchased seed-cocoons being required to be tested.

Propaganda. Five assistant demonstrators located in different places demonstrated rearing of mulberry and *Eri* silkworms.

Research. The Pathology Assistant for investigation of diseases financed by the Government of India joined on 12th December 1935.

Reeling. A successful demonstration of the Japanese foot-reeling machine has resulted in several reelers either adopting this machine or fitting buttons, pulleys, etc., to their machines.

Eri silkworms. A trial for utilisation of *Eri* cocoons with the help of Messrs. Lister & Co., Ltd., Bradford, England, showed that there was no prospect of profit to growers of these cocoons. The proposed Mysore Silk Spinning Mills also held out no hopes. Therefore operations for encouragement of rearing of *Eri* silkworms were stopped at the end of the year.

Silk worm gut. On examination of samples supplied to the Madras General Hospital, an order was received for 1,000 guts which were required to be ten inches long. Such long guts were available only from univoltine or superior hybrid races.

ASSAM. *Seed supply. Eri, Muga* and mulberry silkworms (locally known as *Pat*) were dealt with by this department which grew food plants for all the three in its farms and raised and supplied seed-cocoons and eggs to rearers. The climatic conditions in Shillong proved suitable from about the end of March to middle of October when silk cocoons with very high silk-content were reared from imported French and Japanese and cross-bred races of worms. The Shillong station supplied 10,755 layings and 15,000 seed-cocoons

of mulberry silkworms to different places. Titabar farm supplied seventy-four layings and 21,902 seed-cocoons of *Muga*, 5,793 layings and seventy-five seed-cocoons of *Eri* and 18,221 layings of mulberry silkworms.

Propaganda. With the grant from the Government of India twenty demonstrators were added to the existing six and all were placed in different centres. An Additional Assistant Superintendent was appointed for their proper supervision. They helped in the erection of one hundred model rearing houses.

BURMA. The Japanese method of grafting mulberry was introduced successfully with satisfactory results.

Seed supply. With the Government of India's grant, arrangements were made for starting new stations at Kalama, Shwebandaw and Thaghweplo in addition to the two existing ones at Paukkaung and Leiktho, among rearers for production and supply of disease-free seed. The Central Station at Maymyo with the substation at Mandalay continued to maintain the mother stocks of worms and to carry out hybridisation and selection of worms. The actual supply to the rearers was 22,794 layings and 64,540 seed-cocoons as against 21,560 and 33,884 respectively the previous year.

Training. Twelve persons were trained in mulberry cultivation and rearing in the different stations. The Roman Catholic School at Yedashe taught mulberry cultivation and rearing to its students.

Reeling. Arrangements were made for the manufacture and supply of the foot-reeling machine.

CHAPTER IV

AGRICULTURAL MARKETING*

DURING the year, marketing survey work in respect of rice, wheat, linseed, groundnuts, tobacco, fruits, milk, eggs, live-stock, hides and skins, co-operative marketing and markets and fairs was commenced by the central and local marketing staffs in the provinces and Indian States under the direction of the Agricultural Marketing Adviser to the Government of India. The office of the Agricultural Marketing Adviser was constituted with effect from 1st January, 1935, but it was not until March of that year that the Central Marketing Officers and the Senior Marketing Officers in the provinces and Indian States had joined. During the earlier part of the year under review, the rest of the provinces and most of the major Indian States appointed their marketing staffs and by the end of September, ninety-two full-time marketing officers were operating throughout India and Burma. Of these thirty-two were provided in the provinces out of grants made by the Imperial Council of Agricultural Research, twelve were appointed by the Local Governments and twenty-nine by the Durbars of the major Indian States. In addition to this full-time staff, 223 officers were nominated to deal with marketing in the smaller Indian States and Minor Administrations. Towards the close of the year, the Coffee Cess Committee arranged to appoint a marketing officer for coffee and this officer was temporarily attached to the office of the Agricultural Marketing Adviser.

A programme of marketing surveys was carried out on the basis of the draft synopses and questionnaires passed by a Joint Conference of the Central Marketing Officers and the Senior Marketing Officers of the provinces and Indian States held in Delhi. Over 800 copies of the proceedings were distributed to the parties concerned.

* The assistance of Mr. A. M. Livingstone, Agricultural Marketing Adviser to the Government of India, in the preparation of this chapter is gratefully acknowledged.

Rules for the guidance of marketing officers, the issue of which was agreed to by the joint conference, were also circulated to Local Governments and have been generally adopted by them. These were published along with a list of marketing officers.

In agreement with the respective Governments the local marketing staff in the provinces and major States undertook marketing survey work in respect of those Minor Administrations and States which adjoin or fall within their borders. The number of such States is approximately 120, leaving 210 minor States and Administrations to be dealt with by the central marketing staff direct. There remains outstanding a number of very small States whose trade is not sufficiently significant to warrant special marketing investigation.

In carrying out marketing surveys, and for eliciting primary facts, reliance has been placed on personal interviews by Marketing Officers, assisted by a standard list of questions as set out in the Proceedings of the Delhi Conference. There seems no alternative to this method when the information desired is complex and there is reluctance or indifference on the part of the informants, who are not likely to give detailed information of any value till their confidence has been secured and they are satisfied regarding the object of the particular enquiry. Their assistance and co-operation cannot generally be secured until the Marketing Officer has made himself intimately acquainted with the personnel and practice of the market place, and until he shows a real practical knowledge of the physical characteristics of the products with which he is concerned.

Apart from personal interviews the enquiries are supplemented by means of correspondence and questionnaires in cases where it is desirable to obtain statistical information from certain groups of persons, so long as they are reasonably limited in number—for example, exporters, millers or other manufacturers—but generally in such cases the ground has first of all to be covered by means of personal interviews.

The surveys include also the summarising, checking and utilising of secondary information collected by other agencies, for example,

official statistics, international and railway statistics and also statistics provided by various Chambers of Commerce and Trade Associations.

In practice, the marketing surveys are carried out by the Marketing Officers visiting the centres of concentrated production and also those areas where production is relatively sparse. As a general rule, they begin at the producing end and work up gradually to the chief consuming centres. In all areas they interview representative members of different groups of persons concerned in the production and distribution of the commodity affected, for example, producers, wholesalers, manufacturers, railway agents, etc. Each Marketing Officer is responsible for making sure that the sample interviews are suitably representative of all the different groups of persons engaged in the chain of distribution.

Since the main object of the whole enquiry is to secure better prices for the producer, a considerable amount of attention must be devoted to ascertaining—from merchants' books and other records—the correct prices obtained by producers and also the prices paid by the ultimate consumer. Not only is it necessary for average prices to be studied in producing and consuming centres, but also the seasonal and periodic movement in the prices. The general price structure has to be analysed by sampling, in each district, a number of representative consignments on the way from producer to consumer so as to see what part of the price margin goes in market charges, merchants' commissions, transport costs, etc. Prices must naturally be associated not only with a certain quantity but also with a certain quality of produce. A price-quotation which does not refer to a specific grade or quality of produce is valueless for comparative purposes. Where a commercial description is used to indicate quality, it is essential to know in what sense the description is applied in different markets. It is for that reason that headquarters' work on grade standards has been mainly devoted to an analytical examination of thousands of commercial samples of oil-seeds, cereals, tobacco, etc., drawn from different parts of India.

During the year under review, marketing survey work, in respect of the commodities referred to, was commenced by all the local marketing staffs in the provinces and States. The progress made month by month was reported to the Agricultural Marketing Adviser and submitted to the Imperial Council of Agricultural Research Department. The amount of ground covered before the end of the year depended naturally to a large extent on the date of appointment of the marketing staff in each case. In the latter months the local staffs in the provinces and States were interviewing altogether about 3,000 persons a month in addition to their other work of preparing reports, compiling statistics, preparing crop and stock maps, etc.

The Central Marketing Officers operated in Delhi Province for a month in order to learn marketing survey technique, and a draft report in respect of each commodity was prepared. They later visited the chief ports to study the export and import trade and paid visits to all the provinces and major States in order to consult with and assist the local Marketing Staffs in their surveys. In addition they visited seventy-eight Indian States and Minor Administrations to carry out survey work locally. Altogether the Officers of the Central Marketing Staff spent 2,644 days on tour in the course of the year. Before the end of the year the Central Marketing Staff had compiled most of the statistical data regarding the export and import trade and prepared the first rough draft of the introductory sections of the all-India reports on each commodity.

So far as headquarters' work on grade standards was concerned, arrangements were made in the course of the year for the analysis of commercial samples of linseed to be carried out by the Harcourt Butler Technological Institute, Cawnpore. Similar work for groundnuts was undertaken by the Oil-seeds Specialist, Government of Madras at Coimbatore. Arrangements were made for the analysis of wheat at the Punjab Agricultural College, Lyallpur, and for tobacco at headquarters in conjunction with the Imperial Agricultural Research Institute. The Rice Research Officers in the provinces undertook to do the physical analysis of paddy and rice,

but certain special work on cooking quality was assigned to the Research Officers at Dacca and Coimbatore. In January, 1936, arrangements were made with a firm of tanners to carry out tanning tests on wet salted cow- and buffalo-hides collected by the marketing staff in various provinces and States, and with shippers at Calcutta and Karachi for the analysis of hides and skins arriving from different districts on the basis of the Hamburg system of classification.

Grain and oil-seeds were analysed for refraction (*i.e.*, percentage of impurities, etc.). A chemical analysis of oil- and water-content was made in the case of oil-seeds and cooking tests applied in the case of rice. Tobacco samples were being examined and classified according to various quality factors, *i.e.*, colour, texture, etc.

Up to the end of February 1936, 1,219 commercial samples of wheat had been sent in by Marketing Officers to be analysed at Lyallpur; 710 samples of linseed were received and analysed by the Harcourt Butler Institute; 335 samples of groundnuts by the Oil-seeds Specialist, Coimbatore; 545 samples of tobacco were received for analysis at headquarters. Altogether at different centres 1,177 samples of rice and paddy had been received of which 929 had been analysed.

By the end of the year preliminary marketing survey reports in respect of various commodities had been received as follows :—

Commodity	No. of provinces	No. of major States
Wheat	3	2
Rice	..	..
Groundnuts	2	..
Linseed	3	2
Tobacco	2	1
Fruits	3	3
Milk	1	..
Poultry and Eggs	2	2
Live-stock	..	..
Hides and skins	..	..
TOTAL	16	10

The latest progress reports received from the local marketing staffs indicated that the survey work in most cases was proceeding according to programme.

CHAPTER V

AGRICULTURAL ENGINEERING*

1. Hydraulics

DURING the period 1935-36 marked progress is reported in most of the provinces in the installation of tube-wells, borings, lift-irrigation and the construction of embankments and reservoirs.

The installation of large tube-wells of 5″ and over is mainly confined to the United Provinces, Bihar, Orissa and the Punjab, where the underground strata consist largely of coarse and medium sand yielding large supplies of water.

In the UNITED PROVINCES tube-well installation has become a potent source of irrigation in large-scale farming and the advantages of such underground supplies are afforded to the cultivators by electrified tube-wells constructed in accordance with the five-year scheme reported last year. The cheap hydro-electric energy has brought about the fruition of such a scheme. The number of large tube-wells during the year 1935-36 was 565, of which 488 were State tube-wells. These State tube-wells have enabled nearly 120,000 acres to be irrigated. Besides, 281 of $3\frac{3}{8}$″ diameter wells were installed for irrigating mainly cultivators' fields and gardens. The cordial relationship which exists between the Irrigation and the Agricultural Departments in promoting tube-wells deserves special mention. The agricultural type of strainers, *viz.*, copper-woven sheets wrapped over perforated wrought iron tubes have been largely used, as they have proved eminently suitable for the soils met with in the province.

Besides 10″ tube-wells have been constructed in the UNITED PROVINCES along the main Ganges Canal and a few canal distributaries at suitable intervals in order to supplement the canal supplies and to afford more relief at the tail of the canals. Such wells along the main canal have given discharges of $3\frac{1}{2}$ to 4 cusecs each.

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* The assistance of Mr. P. S. Viswanathan, Agricultural Engineer to Government, United Provinces, in the preparation of this chapter is greatfully acknowledged.

In the PUNJAB eight large tube-wells and twelve small tube-wells were sunk and several trial bores were undertaken to find suitable water for drinking and agricultural purposes. In Shahpur district, the trial bore was taken down to a depth of 631 ft. Down to 490 ft. the water was highly saline but, fortunately, potable water was located lower down. Cadmium-plated Phœnix strainers and the composite type of strainers have been generally used. Coir strainers have proved defective, as successive deterioration in yield was noticed on test. A cheap, reliable and scientifically designed strainer has been found in the New Slotted Pottery Strainer which has been perfected after consecutive experiments and this strainer should prove of lasting benefit to cultivators. It is made in two sizes—$3\frac{1}{2}''$ for discharges of 5,000 to 7,000 gallons per hour and 6″ for 15,000 to 20,000 gallons per hour; the former costs Rs. 3-8-0 per foot and the latter Rs. 6-8-0 per foot.

In BIHAR eight large wells and ninety-seven small wells were completed. Ashford or Tej strainers were used and a new type of strainer suitable for local needs was being designed. The demand for large wells is on the increase.

In other provinces owing to the rocky nature of the subterranean strata such large supplies are rare and uncertain and large borings are disproportionately costly.

2. Well-boring

This activity is of immense benefit to cultivators and, being not so spectacular as the tube-wells, is apt to be overlooked. The individual effect is small, averaging perhaps only ten acres of additional irrigation per well, but the wells treated are many and the cumulative effect in each province has been far greater than that of all the tube-wells in the province put together.

No province is lagging behind in promoting this activity and cultivators are only too willing to grasp the opportunity of improving their masonry wells in order to obtain secure and increased supplies.

In BOMBAY there was an increased demand for boring due to the failure of the rains. Twenty-three boring machines were hired

out, the Kolhapur State taking nine of these. The Kolhapur borings gave considerable relief supplying pure fresh water at a time of drought and cholera. A successful bore was put down at the Poona Leper Asylum at a spot located independently by two water-diviners and a water-finding machine. This gave 900 gallons an hour from a depth of about forty feet in Deccan trap-rock.

In the UNITED PROVINCES 2,126 wells were bored during the year with a percentage of success of 81·6.

In the PUNJAB the total number of wells bored was 420, of which eighty-two per cent. were successful.

In BIHAR AND ORISSA 260 borings were sunk of which 207 were successful (*i.e.*, 79·6 per cent).

In MADRAS the number of borings was 995 of which 671 were successful. Of these, fourteen developed artesian springs giving discharges varying from 30 to 250 gallons per minute to a height of 1 to 4 ft. above ground level. The total number of artesian bore-holes sunk to the end of the year was ninety-seven and such a natural flow, requiring no arrangement to lift the water, should prove of inestimable benefit to farmers. The great progress made in rock-boring in this Presidency merits special mention and affords a great fillip to the exploration of underground supplies in other provinces with similar rocky strata. In the United Provinces similar exploration of the rocky strata in Bundelkhand district is in hand.

Recognising the value of the work, a large sum from the Rural Development Funds has been diverted in the United Provinces and the Punjab towards the improvement of open wells by boring, by giving substantial subsidies to cultivators towards the cost of such work. Excellent progress has been reported in the above two provinces. In SIND a light boring machine is being devised to encourage small borings.

3. Water-lift and Lift-irrigation

Supplies from large tube-wells of 5″ and over have to be tapped by power-pumping plants. In the UNITED PROVINCES and the

PUNJAB and in places in MADRAS, electric motor pumps were installed, as cheap electric energy was available. In other areas, oil-engines with horizontal centrifugal pumps were used. The horse-power of the motors usually ranges from 7½ to 12½ and that of the oil-engines from 10 to 20. In the United Provinces besides the several pumping plants installed over the tube-wells, two plants were installed for pumping from rivers. The possibilities of irrigation facilities in the Eastern district by pumping from different rivers were investigated and, as an experimental measure, Government approved of a small scheme which provided for pumping 160 cusecs from the Gogra river and erection of a power house to supply energy for working the pumps and electrifying Fyzabad town. This scheme will command 1,01,076 acres of cultivated area in the *Doab* between the Gogra and the Marha rivers and irrigate 43,248 acres annually. Four experimental tube-wells equipped at present with oil-plants have been working in Fyzabad for the benefit of the cultivators. Further experimental borings in the area are in progress.

In BIHAR AND ORISSA the demand for power-pumping plants had followed in the wake of the demand for large tube-wells and a rapid development is anticipated.

In MADRAS fifty pumping plants were erected on payment of a nominal fee, their B. H. P. varying from 1 to 34; 169 acres were benefited thereby. Besides these, in Madras fifty oil-engines and pumps are maintained by the Department for hire to cultivators either to pump water during periods of drought or for well-sinking. In the United Provinces a few oil-engines and pumps which had been released as a result of their replacement by electric plants were let out on hire to zamindars and cultivators for pumping water or for driving agricultural machinery.

4. Improved Water-lifts for Bullock-power

The agricultural public appreciate that a good masonry well improved by boring and provided with an efficient *rahat* (Persian wheel) is, under existing conditions, the ideal appliance for

irrigation in a cultivator's field. Several numbers, locally made, of the all-metal Persian wheel were installed in different provinces. But owing to keen competition and the consequent race for reducing the price, firms showed a tendency towards low-grade material and crude construction and in some cases the mounting was defective. These defects, when aggravated by deficient lubrication, reduce the efficiency of the gear assembly considerably.

In the UNITED PROVINCES, a few Kirloskar " Kifayat " *rahats* were installed and were found very efficient. Its scientific design, good quality of material and approved workmanship have mitigated the friction of the several parts considerably and the bullocks are able to work the wheel easily and quickly even from depths of forty feet of the spring water level. Its cost of Rs. 320 is, however, such that an ordinary cultivator cannot take advantage of such a useful type. The firm is alive to this fact and is endeavouring to cheapen it without in any way impairing the efficiency of the appliance. Several other types, such as Maya Das lift and Punjab type of which the price varies from Rs. 150 to Rs. 180, are in common use in the province.

In MADRAS, an attempt is being made to improve efficiency by substituting machine-cut gears and tapered roller bearings mounted and totally enclosed in a small and compact oil-filled housing. A sample of this new design is under construction and it is reported that such an improvement is not likely to increase the cost to any considerable extent. The improved circular *mhot* has been now well tested and gives very satisfactory service and a number of such *mhot* have been made ready for installing in ryots' farms. Unfortunately this simple and efficient device is restricted in its application to lifts not exceeding twelve feet. The swing basket swung by two men has been tested to give 4,000 to 5,000 gallons per hour against lifts of $2\frac{1}{2}$ to 2 ft.

In BIHAR AND ORISSA, local foundries and village blacksmiths sold a large number of *rahats* during the year at a price of about Rs. 100 for the *rahat* provided with hard wood or ordinary C. I. bearings. The ball-bearing type costs Rs. 165 and designs for a

cheaper type were under consideration. Besides thirteen *rahats*, six Archimedean screw lifts were supplied by the Department.

5. Embankments and Channels

It has been stated in the last year's report that embankments and channels are the two chief factors of irrigation and land improvement in India. In a country where a large percentage of the annual rainfall runs off the fields into *nalas* carrying with it much fertile soil, embankments which check such flow or wastage of water and channels which enable economical distribution of water are admittedly essential.

Most provinces possess the technical staff in order to render help to the cultivators in surveying and levelling with a view to construct embankments cheaply and efficiently and to align channels effectively.

In BOMBAY, the Professor of Agricultural Engineering, Physics and Mathematics continued his studies of soil erosion at various centres. Sheet erosion and gully erosion are being studied and measured on both a small and intensive scale and a larger and more extensive scale. Results are so far tentative. Heavy rains in September and October did much of the erosion near Poona. In the West Khandesh, East Khandesh and Nasik districts of the Bombay Presidency about 1,500 acres were protected against erosion by a method of making long low contour bunds using a tractor and a special implement. In the Poona, Sholapur, Ahmednagar and Satara districts, the Bunding Officer, whose post had been revived, dealt with sixty applications for technical advice on bunding work. In the southern districts of the Presidency (Dharwar, Belgaum, Bijapur), fifty-one schemes were prepared by the Deputy Director's staff, the post of Bunding Officer there being still in abeyance.

In the UNITED PROVINCES, the Agricultural Department has a few sub-overseers under the Agricultural Engineer for the purpose. Several bunds have been constructed across depressions and catchments so as to impound the water of small areas and to check erosion, chiefly in the eastern districts. A few embankments have been constructed in Bundelkhand and adjoining districts so as to

retain water on the fields in order to enable *rabi* sowings. This scheme of embankments and reservoirs is one of the chief features of Rural Development and great assistance is being given out of such funds. As the soil in Bundelkhand is heavy black cotton, locally known as *mar* and *kabar*, a high power Diesel tractor and Brush-breaker plough are used to break up the soil and the loose earth is dressed up into embankments to a height of about 18" by manual labour.

In BIHAR, the staff consists of a Bundi Inspector and a Surveyor. Seven irrigation schemes were surveyed and plans and estimates prepared.

In BENGAL, a few surveys were undertaken in connection with irrigation.

6. Agricultural Implements and Machinery

This year has been marked by great activity in many provinces in improving the existing cheap implements and in devising new ones suitable to local needs.

In the UNITED PROVINCES several types of ploughs, chiefly those manufactured by Kirloskar Bros., Ltd., were tested and improvements suggested. A suitable design of Olpad Thresher which has been under trial for the last three years has now been standardized at a cost of about Rs. 35. It makes for quicker work. A pair of bullocks, working this thresher, threshes 100 mds. of wheat in about forty to forty-five hours, while by bullock treading, two pairs of bullocks take fifty to fifty-five hours. This thresher has gained great popularity. The Akola hoe has been cheapened in cost by mass manufacture and it has become very popular among the cultivators for hoeing sugarcane. A few winnowers were manufactured and gave satisfaction. The problem of cheapening the winnowers to make them popular among somewhat well-to-do cultivators is engaging the attention of the Department. A cheap type of seed-drill has been designed and is being tried. A useful cheap attachment to the plough, which can be locally made, has been designed in order to facilitate line-sowing of crops.

In BOMBAY the Agricultural Engineer continued work on seven different implements or machines, namely, (*a*) improved seed-drill, (*b*) winnowing fans, (*c*) wheat-thresher, (*d*) ball-bearing bullock-cart wheels, (*e*) soil-scooper, (*f*) groundnut-digger, (*g*) ring-cutting machine. The light-weight seed-drills, specially made for cotton, are definitely a success on account of their automatic and uniform sowing and decreased draught. The soil-scooper at Sholapur gave very good results in preventing run-off of water. The cheap-winnowers have been much appreciated, the chain-drive being superior to the rope-drive. It is proposed to substitute a belt for the rope.

In BIHAR and ORISSA Norag threshers are still in demand and the improved Olpad thresher is in hand.

In the CENTRAL PROVINCES, a new pattern Akola Hoe suitable for Berar has been designed for hoeing and interculture.

In BENGAL, two types of pole ploughs, costing Rs. 7-8 each, were devised for general ploughing work, including puddling for transplanted *aman* (winter) paddy. A third type of beam plough was designed and tested. It costs Rs. 17 only. Other implements which were constructed were the hand-cultivator, inter-cultivator and " Roy " cultivator.

In MADRAS Cooper No. 11 and 26 and Kirloskar No. 14 and Gurjar No. 2 are popular. Several types of ploughs were constructed and tested to be satisfactory and their production by manufacturers has been taken up. An improved mechanical device for polishing turmeric has been evolved after several trials. The final design consists of a horizontally mounted expanded metal barrel which is rotated by hand. A barrel three feet in diameter, two feet long, taking a 70 lb. charge of boiled and well-dried turmeric, provided the best combination of efficient action, high output and comfortable working load for two coolies. The saving effected by this appliance is nearly Rs. 5 per acre against the indigenous method of vigorously shaking in hanging bamboo baskets to which a few rough stones are added as a polishing agent. The cost of the drum is Rs. 30.

Another useful implement devised is the Grain Polisher for removing the yellow seed-coat from the grain of the large yellow

cholam (*Andropogon Sorghum*) for conducting malting experiments. Its effect in the defibration of cotton seed is also being tried. Two hand-powered groundnut decorticators, *viz.*, the " Branda " system machine from the Atelier des Plombieres, Marseille, France and the improved patent sheller of Messrs. Richmond and Chandler, Ltd., were tested. The former proved unsatisfactory as the screens got choked up and as two men found it strenuous to work it. The latter effected a very clean shelling with a low percentage of unshelled and broken nuts when the beater-shaft rotated at a speed of 150 revolutions per minute. The capacity was 60 lbs. of nuts per hour. The load was uncomfortably heavy even for two coolies. Power-drive was applied and with belt at the shaft speed of 360 revolutions the capacity was 2 cwts. of unshelled nuts per hour. Further tests are in progress.

In SIND a hand-power winnowing machine with grading attachment, simple in construction and efficient in working, has been made in two sizes, (1) for winnowing 30 to 40 mds. of threshed corn per hour and (2) for 10 to 15 mds. per hour. The former costs Rs. 252 and the latter Rs. 160. Different sized sieves and alterations in the angle of shutters (salts) permit of treating different kinds of cereals. Another implement devised is the inter-cultivator costing Rs. 12 for inter-cultivation of cotton.

In MYSORE two Eureka ploughs were made and tried and ploughshares made at the Rama Krishna Krishisala were found to be efficient and cheap. A local balcksmith had made a Kolar Mission pattern plough costing Rs. 12. The improved seed-drill has become popular. The use of cheap and durable timber in manufacturing bee-hives is under experiment.

A five-year scheme prepared by the Sugar Technologist for a research and testing station for the indigenous system of sugar and *gur* manufacture was approved by the Imperial Council of Agricultural Research. This scheme provides an experimental station for the purpose of testing existing processes and machinery used for the manufacture of *gur*, *rab* and sugar by indigenous systems, for conducting trials of new plant and processes and for research

work with the object of introducing improvements. The station will also provide training for operatives in improved methods. Bilari town in Moradabad district has been chosen, as it is a good centre for sugarcane supply, a typical centre of the *khandsari* industry and has cheap electric power available.

Grants were given by the Imperial Council of Agricultural Research in 1930 to the different provinces for devising satisfactory small-power crushing mills. Both in the UNITED PROVINCES and BIHAR and ORISSA, suitable crushers have been standardised after exhaustive trials and arrangements made with firms for their large-scale manufacture. In the PUNJAB a type was evolved and given a thorough trial, but it was not found superior to those already in the market. Hence it was not considered worth-while to continue the work. In BENGAL the K. B. type of 1½ ton cane-mill was further improved with a view to lighten and cheapen its construction and improve its efficiency. The Sugar Technologist, with the aid of a grant from the Imperial Council of Agricultural Research, devised a new *bel* for using moist bagasse, thus rendering the work more independent of weather conditions. Assisted by a similar grant, the Government of Bihar and Orissa are investigating the manufacture of sugar by a single-pan process instead of the common multiple pans, special attention being given to questions of fuel economy and inversion of sucrose. This scheme is nearing completion.

Valuable experiments were in progress in Bengal in improving the methods of manufacture of open-pan sugar and a system has been evolved whereby recovery of as much as 8·5 per cent has been obtained in small-scale experiments.

In MYSORE, an improved jaggery-boiling furnace resulted in economy in fuel of up to Rs. 50 per acre of cane milled.

Besides these experiments and manufacture work, crushers and other implements were often hired to cultivators on easy terms in several provinces with a view to propagate their use and bring about better outturn.

7. Mechanical Cultivation

The experiments conducted under the auspices of the Imperial Council of Agricultural Research in mechanical cultivation and their records have been very helpful in providing technical data for different provinces to conduct further investigations on the feasibilities of tractor cultivation and the choice of tractors.

In the UNITED PROVINCES the chief value of the tractor lies in quick cultivation of the large farms, in eradicating *kans* (*Saccharum spontaneum*) and other deep-rooted grasses by ploughing to a depth of 12″ and in reclaiming *usar* and *banjar* lands which have lain uncultivated for years. Several large farmers have purchased Diesel tractors, largely of the Caterpillar type. Two Caterpillar Diesel tractors of 40 and 50 H. P. respectively were purchased by the Department in 1934 and 1935 mainly for *kans* eradication work. Prior to 1934, contracts for ploughing 10″ deep were given to firms but as 10″ ploughing was found inadequate for *kans* and as contractors showed reluctance to undertake deeper work, the departmental tractors were used for 12″ deep ploughing in *mar* and *kabar* soils in Jalaun and Jhansi districts which have abundance of *kans* growth. Work proved very effective and zamindars and cultivators are coming forward to have their lands ploughed. Such work is limited to about four months, *i.e.*, from December to April as *kans* uprooted before December cannot be exposed to the hot sun for killing further growth and as the soil becomes too hard after April to be penetrated by even the heavy-duty plough. In the 1933 season, 121·3 acres were ploughed, in 1934 the same area was reploughed, in 1935, 143 acres and in 1936, 137 acres. The rate per acre has varied in different years and an average rate of Rs. 18 per acre is reasonable. Work turned out by the Giantrac Mouldboard Plough has been found more effective than the Shuga Disc Heavy-Duty. A third Caterpillar Diesel of 35 H. P. has been purchased for the Cattle Breeding Farms. When free from *kans* work, the first two tractors are used for ploughing hard lands in other districts on contract.

In HYDERABAD Mr. R. S. Parakh of Saila, District Parbhani, continued contract work with his five tractors with the co-operation of the Department and ploughed 903 acres during the year.

In SIND Caterpillar 35 Diesel worked for 2,452 hours during the year and ploughed 502 acres, cultivated 1,530 acres and scraped 723,000 c.ft. of earth. The tractor stood up to its work very well and is likely to play an important part in the future economic condition and agricultural development of the province.

Fowler's steam tackle, twenty-three years old, did excellent work in laying out and levelling land at the Imperial Agricultural Research Institute, New Delhi. Vicker and Lanz Bulldog tractors were used in Karnal in *rabi* cultivation. Farmall 9/18 H. P. row crop tractor was used for interculture of sugarcane and ridging it up before the monsoon.

It is encouraging to find that tractor experts of different tractor firms inspect the sites before advising purchase of suitable tractors and implements. Firms have begun to realise the necessity of service and of keeping a good stock of spare parts for supply at short notice. The chances of tractors lying unused on account of unsuitability for want of parts have been thereby considerably minimised.

CHAPTER VI

LIVE-STOCK

1. General remarks

DURING the year under review, the figures of the Live-stock Census taken in January 1935 became available. This is the fourth census taken since the Government of India decided, in consultation with Local Governments in 1919, to take a live-stock census quinquennially. Due to financial causes, three provinces, Bengal, Bihar and Orissa, did not take part, but the 1935 census was noteworthy for two reasons, *viz.*:—(*a*) an improved classification was introduced designed to elicit more information than hitherto and (*b*) a larger number of Indian States took part in it. The last census taken in 1930 related to only about fifty per cent of the area covered by Indian States, whereas the present census brought sixty-six per cent of the area under its operation. As a third of the Indian States area is still uncovered by the census, it is not possible to comment upon the figures from States. In British India, omitting Bengal, Bihar and Orissa from the calculation, the census shows an increase, during the quinquennium, of 4·9 per cent in bovines—the increase being 9·4 per cent in buffaloes and 3·3 per cent in cattle. Sheep decreased by 6·7 per cent and goats increased by 4·5 per cent. Horses increased by 4·6 per cent but mares and young stock decreased in number and the net increase in the class 'Horses and Ponies' was only 1·1 per cent. Mules decreased by 11·6 per cent and donkeys increased by 7·1 per cent. Assuming that the live-stock population of Bengal, Bihar and Orissa was the same as at the 1930 enumeration, the following are the figures for British India in millions :—

	Millions
Bulls and Bullocks	51
Cows	39
Young Stock	35
TOTAL (OX TRIBE)	125

Male Buffaloes	6
Female Buffaloes	15
Young Stock	13
TOTAL BUFFALOES	34
TOTAL BOVINES	159
Sheep	25
Goats	37
Horses and Ponies	1·5
Mules and Donkeys	1·5
Camels	0·6

In connection with the live-stock industry of this country, it will be of interest to refer briefly to some figures relating to imports and exports of animals and animal products. The total values of imports into and exports from India of animals and animal products during the last five years were as under :—

Year	VALUE IN LAKHS OF RUPEES Imports	Exports
1931-32	424·6	1,408·0
1932-33	529·7	1,051·5
1933-34	490·0	1,321·0
1934-35	563·8	1,214·4
1935-36	478·9	1,409·0

It will be observed that the annual variation is not considerable, and that, on the balance, India is an exporting country ; the value of exports exceeding that of imports by over Rs. 9 crores in 1935-36.

Analysis of these imports and exports for 1935-36 gives the following figures for the different products :—

	VALUE IN LAKHS OF RUPEES Imports	Exports
Live animals	20·4	9·4
Hides and skins	29·7	968·1
Finished leather goods	67·5	7·9
Wool	222·4	295·3
Dairy products	85·5	17·0
Other products	53·5	111·3
	479·0	1,409·0

Live animals. Of the twenty lakhs of rupees representing the value of imports, rupees eighteen lakhs is on account of horses and the rest ' other animals '. Imports of horses have more than

halved during the last five years—4,962 horses were imported in 1931-32 but in 1935-36 the number was only 2,338.

In exports the largest share is claimed by sheep and goats which account for rupees seven lakhs out of the total value of rupees nine lakhs. Other animals account for another one lakh of rupees, while cattle claim only an insignificantly small proportion, namely Re. 0·42 lakh. Export trade in cattle and sheep and goats has steadily dwindled from 756 cattle and 67,533 sheep and goats in 1931-32 to 407 cattle and 39,913 sheep and goats in 1935-36.

Hides and skins. Of the total imports valued at rupees twenty-nine lakhs, rupees ten lakhs are represented by raw hides and skins, rupees eleven lakhs by tanned and rupees eight lakhs by unwrought leather. Import figures remain more or less steady. The amount representing exports was made up of Rs. 413 lakhs of raw hides, Rs. 520 lakhs of tanned hides and rupees thirty-four lakhs of unwrought leather.

Finished leather goods. These consist of boots and shoes, bags and trunks, leather belting, saddlery, etc. Of these, about Rs. 67·5 lakhs are imported annually, of which shoes claim rupees twelve lakhs and belting and other accessories for machinery about rupees forty-five lakhs.

Exports work out only to Rs. 7·9 lakhs.

Wool and woollen products. Of the total value of imports of wool and woollen products, rupees forty-four lakhs or only twenty-five per cent is represented by raw wool and the rest is made up of finished products. Rs. 209 lakhs or seventy per cent of the total value of wool exported are on account of raw wool.

Dairy products. Rs. 85·5 lakhs worth of dairy products are imported yearly, sixty-five per cent of which, or Rs. fifty-four lakhs, is in respect of preserved and condensed milk, twenty per cent in respect of milk-foods for infants and invalids and about eight per cent each by butter and cheese. Though the value of these imports has not appreciably increased during the last five years, the quantities have considerably increased. This increase is mainly in respect of butter and less marked in the case of cheese and condensed milk.

The value of exports amounts to rupees seventeen lakhs of which rupees fifteen lakhs is on account of ghee and rupees two lakhs on account of butter. Exports of butter have diminished by thirty per cent in value and by about twenty-five per cent in quantity. The decrease in export of ghee is about eleven per cent in quantity.

Other products. The value of imports and exports of other products is respectively Rs. 53·5 and Rs. 111·3 lakhs. Major items of imports are canned and uncanned fish (Rs. 33 lakhs), bacon and hams (Rs. 12 lakhs) and animal oils including fish oil (Rs. 4 lakhs). Major exports are salted and unsalted dry fish (Rs. 39 lakhs), bones for manufacturing purposes (Rs. 32 lakhs), bones for manure (Rs. 10 lakhs) and bone-meal (Rs. 14 lakhs).

Cattle-breeding operations were carried on as usual at the Farms maintained by the Central and Provincial Governments and the improvement of cattle by controlled breeding, systematic castration and some form of premium for the maintenance of stud bulls was in operation in most Provinces and some States. The number of approved bulls at stud during the year in British India showed an increase of about thirteen per cent over the average for the past three years but the total number of approved bulls at stud was still grossly inadequate for the huge number of cows to be served. The personal interest of His Excellency the Viceroy in Indian agriculture and rural development, and in cattle breeding in particular, has, however, recently focussed attention on live-stock improvement, and it is to be hoped that in course of time more adequate arrangements will be made for the production and supply of suitable bulls.

At present most provinces lack an animal husbandry organization with the necessary funds and staff to provide for the care and improvement of live-stock of all kinds on an adequate scale and to develop animal industry on improved lines, but in order to encourage the production of pedigree dairy cattle by private breeders, the Imperial Council of Agricultural Research decided in February 1936 to initiate and maintain Herd Books for seven of the most important indigenous breeds of dairy cattle, which step should

materially assist in the development of high yielding strains of Indian dairy cattle.

During the year orders were passed for the transfer of the Animal Nutrition Section from Bangalore to Izatnagar, and this section will henceforth be under the control of the Director of the Imperial Veterinary Research Institute. The inter-relation between diet and disease has long been recognised and Izatnagar has many advantages for the location of an Animal Nutrition Research Laboratory. Large numbers of animals suitable for experiment are available; other research workers, on disease problems, are close at hand and access to the Library of the Muktesar Institute, one of the largest of its kind in the East, is easy. Moreover, since it has been decided also to locate a Poultry Research Section at Izatnagar, the problems of nutrition of poultry in relation to both health and disease will be studied alongside those of the larger animals.

Systematic investigation of stock-diseases was in progress in all Provinces and in certain Indian States, under grants made by the Imperial Council of Agricultural Research and these showed that other less fatal disease conditions, regarding which exact knowledge was previously lacking, are of as great economic importance as the better known cattle-plagues. More attention was consequently paid to such conditions and, during the year, arrangements were completed for dividing the staff of the Imperial Veterinary Research Institute into the following main sections, *viz.*:— Pathology and Bacteriology, Serology and Veterinary Zoology, each under a specialist. Thus, in future, at this institute it will be possible for disease problems sent up from the provinces to be dealt with each by a specialist in the particular branch of science concerned, working in close collaboration with research workers in nutrition; which in India is an extremely important factor in the causation of disease.

2. Contagious diseases and their control

Detailed figures of reported mortality from contagious diseases for 1935-36 are given in Appendix X. The following is a summary

of the position in British India for the six years 1930-31 to 1935-36 :—

Year	Total reported mortality	Mortality from Rinderpest		Total number of animals inoculated
		Number	Percentage of total	
1930-31	316,900	203,758	64	1,548,982
1931-32	217,413	182,441	67	1,585,199
1932-33	300,317	209,524	70	1,734,229
1933-34	286,592	179,877	63	2,230,876
1934-35	227,809	124,755	62	2,422,577
1935-36	249,862	138,212	55	3,138,125

It will be seen that though the position in regard to mortality is better than it was six years ago, the loss due to contagious diseases is still considerable. During the year under report, mortality has gone up by about 22,000 over the previous year. This increase is mainly from Bengal and Burma, which have had very severe outbreaks of Rinderpest, and to a less extent from Bombay, the Punjab and Assam. The largest amount of mortality is reported from Bengal, the figure being 43,000. Next comes Burma with 39,000 and then the United Provinces and the Punjab with 29,000 each.

Columns 3 and 4 of the above table show the importance of Rinderpest and the toll it levies on the animals of this country. The proportion of deaths due to Rinderpest has steadily fallen of late and during the year under report it has dropped by seven per cent from sixty-two to fifty-five. This drop may be ascribed to the increasing use of an active form of immunisation, particularly that known as the goat-virus method of vaccination. This method,

as pointed out before, has been extensively tried both in the face of outbreaks and for conferring lasting immunity in susceptible animals, and is now accepted throughout India as the cheapest and most efficient method of Rinderpest inoculation. Out of the total of over 3·1* millions of inoculations performed during the year, 1·9 millions, or about sixty per cent, were against Rinderpest. These 1·9 millions were distributed amongst the different methods as under :—

	(Figures in thousands)
Serum-alone	474 or 25 per cent
Serum-simultaneous	112 or 6 ,,
Goat-blood virus	225 or 12 ,,
Goat-tissue virus	10,75 or 57 ,,

Complete figures of mortality among the inoculated are not available, but such figures as could be obtained show the mortality after inoculation to be as follows :—

Serum-alone	4·3 per 1,000.
Serum-simultaneous	0·36 ,, ,,
Goat-blood virus	1·05 ,, ,,
Goat-tissue virus	6·7 ,, ,,

The comparatively large proportion of deaths in the case of goat-tissue virus is due to the employment of this method against certain virulent outbreaks of Rinderpest in Bengal. In these outbreaks 368,831 animals were vaccinated, out of which 6,850 or about eighteen per thousand succumbed, and it may be presumed that many of these animals were incubating the disease at the time of inoculation.

3. Local diseases and public health work

During the year under report there was an increase in the number of hospitals and dispensaries and in the activities of the staff in regard to local diseases and public health work. Detailed figures

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* These figures are compiled from Appendices to Civil Veterinary Department Reports, and are not quite complete. Steps have been taken to make these appendices more complete and uniform in future.

are given in Appendix X. The following comparative statement for the last three years will be of interest :—

	1933-34	1934-35	1935-36
Number of hospitals and dispensaries	1,043	1,059	1,078
Number of cases treated in hospitals and dispensaries . . .	2,830,152	3,008,571	3,476,739
Number of cases treated in hospitals and dispensaries on tour . .	1,814,791	1,969,869	2,283,127

Among other activities of the Civil Veterinary Departments, the most important is propaganda work. This consists of (*a*) issue of pamphlets in the local vernaculars regarding common diseases and their control, hygiene, breeding, first aid treatment, etc., (*b*) lectures in agricultural schools, rural development classes, etc., (*c*) attending fairs and shows and running veterinary sections in exhibitions. Other work includes meat inspection, investigation of cases of criminal poisoning, and treatment of cases convicted under the Act for the Prevention of Cruelty to Animals.

Certain figures exist regarding recognised slaughter-houses in India and of the numbers of animals slaughtered in them, but these are not reproduced as they are not complete. In view of the importance of information of this kind, arrangements have been made for the maintenance of accurate records of the different kinds of animals slaughtered and of other relevant information connected therewith. It is hoped that these will hereafter be included in the appendices to the Annual Reports of the Provincial Civil Veterinary Departments.

4. Breeding operations

(*a*) **Cattle.** As an introduction to this Section, two statements are reproduced below showing (i) the number of approved bulls at stud in British provinces during the past seven years, and (ii) the number of castrations performed by the Veterinary Departments of the provinces over the same period. The figures of castration per 1,000 males in 1935-36 from the Punjab and North-West Frontier Province are very striking, while the Central Provinces are evidently making a determined effort to see that this very important part of

any live-stock improvement campaign is given due prominence in their programme of work.

(i) *Statement showing the number of approved bulls at stud*

Province	1929-30	1930-31	1931-32	1932-33	1933-34	1934-35	1935-36
Madras	76	115	121	127	134	141	181
Bombay	79	92	137	185	219	219	289
Bengal	47	69	120	263	393	423	487
United Provinces . .	2,341	2,731	3,015	3,194	3,237	3,303	3,448
Punjab	3,359	3,517	3,857	4,096	4,182	4,686	5,033
Burma	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*
Central Provinces . .	47	84	89	84	104	124	132
Bihar	16	16	18	15	19	17	16
Assam	20	30	45	73	113	158	200
North-West Frontier Province.	125	156	230	241	234	223	234
Sind	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	2
Orissa	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*	*Nil*

(ii) *Total number of castrations performed in various provinces of India*

Province	1929-30	1930-31	1931-32	1932-33	1933-34	1934-35	1935-36	Male bovine population in millions	Castration per thousand males in 1935-36
Madras . .	12,642	23,487	31,699	41,481	52,521	63,565	70,576	11·6	6·1
Bombay . .	28,283	36,841	38,514	27,702	34,373	39,572	42,053	4·9	8·6
Bengal . .	180	344	491	1,945	3,193	4,604	5,868	13·5	0·4
United Provinces.	3,247	16,530	35,279	55,285	72,850	83,709	92,360	15·8	5·8
Punjab . .	364,191	290,422	436,561	476,587	513,331	555,709	576,333	6·9	83·5
Burma . .	86	77	80	45	12	5	35	..	..
Bihar and Orissa.	71,927	79,243	82,751	94,426	102,445	116,672	130,361	11·0	11·9
Central Provinces	69,453	92,586	107,966	119,160	132,689	160,981	171,659	7·1	24·2
Assam . .	7,219	12,532	17,374	21,272	23,873	28,222	25,733	3·1	8·3
North-West Frontier Province.	38,196	45,672	47,505	52,320	56,499	56,064	51,344	0·5	102·7
Sind . . .	1,528	2,068	2,316	2,292	3,424	3,495	3,528	1·0	3·5

At the Hissar Farm in the PUNJAB there were 6,753 cattle on the books. There was a drop in births from 2,533 in the previous year to 2,338 in the year under review, and this is ascribed to the total failure of the monsoon in 1934-35 and the fact that Hariana cattle do not thrive as well when under stall-feeding conditions as when grazed. The number of bulls issued was 616 at a book-value of Rs. 2,44,485. A concession rate of Rs. 46,000 only was paid by breeders for these animals, leaving Rs. 1,98,485 as the contribution of the Local Government for the development of cattle-breeding. In the Hariana tract, there were 2,255 pedigree bulls at stud as compared with 2,107 in the previous year. In the Dhanni tract, there were ninety-one District Board bulls and 232 subsidy bulls at work as compared with seventy-six District Board bulls and 279 subsidy bulls in the previous year. In this tract the breeding of better cattle is said to have caught the imagination of the local zamindars and there is also a big demand for pedigree bulls from this tract for breeding purposes in the North-West Frontier Province. There were 2,516 buffalo stud bulls at work in the Punjab during the year. In the NORTH-WEST FRONTIER PROVINCE there were 204 Dhanni bulls in the Province as against 191 in the previous year. It is said that the influx of these bulls has already greatly improved the working capacity of the local bullocks.

In BIHAR AND ORISSA, the Phulwari Farm issued eight Tharparkar bulls and the Sepaya Farm six buffalo bulls for stud purposes, but the general cattle-breeding policy of these provinces was still under consideration during the year. In MADRAS, forty-two bulls, forty-five cows and fifteen calves were issued from the Hosur Cattle Farm for breeding purposes. Herds of Scindi, Kangayam and Hallikar cattle were maintained at Hosur, while a small Ongole herd and a few buffaloes were located at Guntur.

In BOMBAY, as a result of a grant from the Rural Uplift Fund, a scheme for the improvement of buffaloes has been introduced. It is intended to investigate the following problems in the first place :—

(*a*) To ascertain which of his stock is paying the ryot;

(*b*) To select the best of his male buffaloes for further improvement of the herd;

(*c*) To examine methods now employed for utilization of milk and suggest ways of obtaining better results.

The number of pedigree stock of the Khillari, Gir, Kankrej and Amrat Mahal breeds registered during the year was 334, making a total number of 2,084 animals now registered in this province. In BENGAL additional Live-stock Officers have been appointed and it is now proposed to undertake extensive cattle improvement in ten districts. In each of these districts, one Live-stock Officer and one Veterinary Officer will be posted and each will be provided with one hundred stud bulls from the Rural Uplift Grant. At the same time an intensive campaign of castration among scrub bulls will be undertaken.

In the UNITED PROVINCES the old system of issuing breeding bulls free on loan to a village was changed to a payment scheme, by which a contribution of rupees twenty-two per bull is made for the services of a bull throughout its useful life. The number issued on this contributory system was 192, against only eighty-seven in the previous year, showing that the cattle-breeder realizes the value of a good stud bull and is prepared to pay for it. The same cattle-breeding farms were maintained as in previous years. In the CENTRAL PROVINCES a number of small cattle-breeding farms, dealing with those breeds which are considered most suitable for the tract concerned, are maintained, but it is pointed out that for the production of bulls which can be used for improving the cultivators' cattle, only 283 cows are available. Allowing for casualties, there is therefore little prospect of the output of bulls from Government farms exceeding fifty *per annum*, and this number can have little or no effect on the three million cows which the province contains.

In ASSAM a serious check to the progress of cattle improvement occurred during the year owing to an outbreak of Johne's disease in all the Government farms. A technical committee investigated the position in January, 1936, and made recommendations which

were accepted by Government and immediately put into action. The chief of these was that no bulls should be issued from Government farms for a period of two years. Cattle improvement work on the same lines as in previous years was continued in the North Goalpara Forest Reserve and in certain notified professional grazing reserves and village breeding areas, and encouraging results are reported.

In HYDERABAD the demand for breeding bulls is said to be increasing and there were twenty-five bulls on the registers of the Veterinary Department. Nine Amrat Mahal bulls were at work in Amrabad taluqa and ten in the Nizamnagar Development Area. During the year 28,874 castrations were performed. In TRAVANCORE there were no cattle farms under the control of the Department of Agriculture, but stud bulls were maintained at veterinary hospitals in the state. The number of castrations performed was 1,961.

(*b*) **Other animals.** Since 1933, the average daily milk-yield of the herd of goats at the Mission Farm, Etah, UNITED PROVINCES, which is maintained from a grant made by the Imperial Council of Agricultural Research, has increased from 1·9 lbs. to 2·5 lbs. *per diem*. The number of days in milk has decreased from 269 to 167, and the cost of production was reduced during the year from 7·3 to 7·1 pies per lb.

In the PUNJAB sixty-two male Jamnapari (Beetal) goats and 236 rams were issued from the Hissar Farm—the latter included eighty-two Bikaneri and 154 Hissar dale rams. Comparative yields of wool between these two flocks showed little difference in weight, the Hissar dale averaging 11·15 lbs. and Bikaner 11 lbs.

Seventy-one goat lactations were recorded, the best being 992 lbs. in 246 days. The maximum yield *per diem* was 6½ lbs. During the year seventeen donkey stallions were issued to the districts and eighty horse and eighty-three donkey stallions were at work, but the interest in pony and mule-breeding is said to be subsiding, owing to competition from motor lorries.

In the NORTH-WEST FRONTIER PROVINCE, attention is given to horse, mule, donkey, sheep and goat-breeding, and Jamnapari

(Beetal) stud goats and Hissar dale rams are being introduced. In the UNITED PROVINCES during the year, fifty-six horse and ten donkey stallions were at work, while in HYDERABAD the number of stallions at shed was thirty-five. In ASSAM, the average wool-yield of a flock of Bikanir sheep maintained at the Upper Shillong Farm was four lbs. for ewes and six lbs. for rams. In hardiness, regular breeding and wool-yield, this flock of sheep is said to be most promising.

(*c*) **Poultry.** In the NORTH-WEST FRONTIER PROVINCE a flock of White Leghorn fowls is being maintained at the Tarnab Farm, and considerable attention is being paid to the poultry industry in this province. In MADRAS, several exotic breeds are maintained at the Hosur Cattle Farm and agricultural stations and the demand for eggs from these was great, but the difficulty of controlling contagious disease in this province is stated to be a limiting factor to the development of this industry. In BOMBAY, as a result of a grant from the Rural Uplift Funds, schemes were introduced for—

(*a*) Improvement of village poultry;
(*b*) Encouragement of pedigree poultry keeping;
(*c*) Grading and marketing of eggs by co-operative egg-collecting societies.

In BENGAL, the Dacca Poultry Station lost 478 chickens from Doyle's (Ranikhet) disease in April 1935 and 524 from Fowl Pox later in the year. The sixth Rhodes Indian Red × Chittagong cross continued to prove successful, the best hen laying 240 eggs in the year. In the PUNJAB, a heavy chick mortality, due, it is thought, to some deficiency in the ration, marred the otherwise good results obtained during the year. The sixth generation of buff coloured indigenous fowls was reared and their egg production averaged sixty-seven *per annum* against fifty-nine in the previous year.

(*d*) **Apiculture.** The Imperial Council of Agricultural Research decided to select a man with suitable qualifications and experience and send him abroad for training in bee-keeping, with a view to his being employed by the Council to carry on research at a Central Institute and advise Provincial Governments in the subject.

In the PUNJAB very great progress is reported in bee-keeping. An experimental apiary on up-to-date lines with twenty-six colonies was started at Nagrota and the total quantity of honey obtained from seventeen colonies was 268 lbs. One colony gave a yield of thirty lbs.

5. Dairying

During the year, with a view to making more adequate provision for the systematic development of dairying in India, orders were passed by the Government of India separating from 1st April 1936, the Imperial Dairy Expert's Section from the administrative control of the Director, Imperial Agricultural Research Institute, and placing it directly under the Education, Health and Lands Department of the Government of India. The functions of this new department will be (*a*) advisory and educational and (*b*) research and experiment. In addition to giving various courses of instruction in dairying, including the Indian Dairy Diploma, this department is intended to advise Provincial Departments and the general public in matters of all kinds which affect the dairy industry. For the present, elementary training in dairying will be continued at the Imperial Dairy Institute, but it has been decided that, after a period of five years, instruction at the Central Institute will be confined to more advanced training and the training of post-graduate students, and that elementary training in dairying at suitable Agricultural and Veterinary Colleges should be provided provincially. Experiments and research regarding the handling and transportation of milk and milk-products and general dairy technology will be carried out by the Imperial Dairy Institute, with particular reference to the conditions and requirements of India, and with these objects in view, funds were obtained for enlarging the existing Dairy Institute at Bangalore and to provide a research creamery at Anand, Gujarat.

Systematic selective breeding of the Hariana, Tharparkar, Scindi and Gir breeds of cattle was continued at the Bangalore and Karnal Farms under the Imperial Dairy Expert and all of these breeds

showed improvement in conformation and performance. One Tharparkar cow gave a record yield of 9,800 lbs. in 303 days.

The breeding and management on special lines of pure Sahiwal cattle was also continued under the Imperial Agriculturist at Pusa and it is reported that the system of frequent milking, special handling, massaging of the udder, etc., before calving, continued to effect an increase in milk-yield and a decrease in udder-disease. The daily average yield per cow has now risen to 21·2 lbs. and the number of cows yielding more than 9,000 lbs. in a lactation shows a steady increase.

The average daily milk-yield of the cross-bred, Friesian dairy herd, maintained at the Imperial Veterinary Research Institute, Muktesar, dropped from 18·08 lbs. to 14·6 lbs. during the year under review. This is ascribed to the fact that this herd now contains a preponderance of cows of the F_2 generation which, although satisfactory for experimental purposes, do not yield as much milk as the previous generation.

Out of 241 cows in the Dairy Section of the Hissar Cattle Farm, PUNJAB, 153, including thirty young heifers, gave yields of over 1,000 lbs., including forty-six of 2,000 lbs., twelve of 3,000 lbs. and one of 4,000 lbs. It is pointed out, however, that this Hissar herd has been bred for many years with the object of producing good bullocks and that milk production has been a secondary consideration. Grantee farms in the Punjab now contain a number of Sahiwal cows of good milk performance; the Jahangirabad Farm having two and the Allahabad Farm three, giving 8,000 lbs. and over in a lactation. The Kanke herd in BIHAR, consisting of both Sahiwal and Tharparkar cows, gave an increased yield of 16·7 lbs. *per diem* as compared with 15·1 lbs. in the previous year. The average of the Murrah buffalo herd at Sepaya rose from 12·5 lbs. to 13·8 lbs. *per diem.* At the Phulwari Farm, Patna, the average daily yield of the Tharparkar herd was 12·2 lbs.

The Scindi herd at the Hosur Cattle Farm, MADRAS, averaged 12·4 lbs. per cow per day, and one cow gave 6,300 lbs. in a lactation. Milk-recording in the Kangayam herd maintained at this farm is

also practised, and the average of fifty-eight cows was 6·9 lbs. per day, but one Kangayam cow had a daily average of 14·7 lbs.

In connection with the Palghar Dairy Scheme, the BOMBAY Government have now leased 508 acres to one firm and 537 acres to another for the establishment of dairies for the supply of milk to Bombay city. The demand for land under this scheme is so great that the Local Government are considering to set aside an additional area of about 1,000 acres for the purpose. A small herd of Scindis was maintained at the Government Fruit Farm, Mirpurkhas, SIND. The best lactation recorded was over 4,000 lbs.

The pure-bred Sahiwal herd at the Telankheri Farm, CENTRAL PROVINCES, consisted of thirty-nine cows, the best of which produced 8,673 lbs. in a lactation or an average of twenty-four lbs. *per diem* through the year. In ASSAM, the cross-bred Friesian herd maintained at the Upper Shillong Farm consisted of twenty-eight cows in milk. The average lactation was 5,840 lbs. in 323 days as compared with 5,907 lbs. in 270 days in the previous year. The appearance of Johne's disease in the jail dairies, which are a feature of animal husbandry work in Assam, interfered with progress to some extent, but the number of co-operative milk societies in this province rose from nine to ten during the year under review.

CHAPTER VII

VETERINARY AND ANIMAL HUSBANDRY RESEARCH

1. Animal health

Losses from contagious disease were still high during the period under review and the activities of Provincial Veterinary Departments had still to be directed mainly to the control of the more fatal plagues of cattle such as Rinderpest, Hæmorrhagic Septicæmia, Blackquarter and Anthrax.

Rinderpest was still responsible for about fifty-five per cent of the recorded mortality and Veterinary Investigation Officers and Provincial Veterinary Departments were much occupied in testing out, in the field, the practical application of the two methods of vaccination with a goat-virus of fixed virulence, mentioned in the last review, which have been evolved from research carried out at the Muktesar Research Institute.

Very extensive field trials all over India have conclusively shown that by these methods it is now possible to control outbreaks of Rinderpest and to confer lasting immunity on cattle at a minimum of expense and with little danger; provided that, in the case of buffaloes, care is taken to control the severity of the reaction by means of a small dose of anti-rinderpest serum.

The virus employed is a fixed one, of reduced virulence for the ox and may be used in two forms, either (*a*) as blood drawn from an infected goat at the height of its re-action to inoculation with fixed virus, or (*b*) an emulsion, in saline solution, of the spleen of goats similarly infected.

Experience has shown that both of these vaccines are effective in controlling outbreaks and in conferring lasting immunity on susceptible animals and large numbers of tests carried out in the field have shown the immunity so conferred to be a solid one in all cases tested. The maximum interval which has so far elapsed from the time of inoculation to the time of the test is a little over three years, while the mortality among cattle of pure Indian blood

as a sequel of inoculation has amounted to only a fraction of one per cent.

In the case of buffaloes, the reaction is, however, liable to be more severe and more variable and in certain cases the mortality has been comparatively heavy.

For the control of outbreaks, both of these methods of vaccination have been successfully employed, on buffaloes as well as cattle, but, in view of the liability to higher mortality among buffaloes, it is at present recommended that a small dose of anti-rinderpest serum should be administered simultaneously with the vaccine to prevent unduly severe reactions.

Vaccination by either of these methods has, in fact, rendered the control of Rinderpest so cheap and easy that it had already been adopted as a routine method throughout British India and arrangements have been made by most Provinces and some States themselves to produce the necessary vaccine, since in either form it does not retain its virulence more than a few days after removal from refrigeration.

Research was continued at the Muktesar Institute in regard to other important contagious diseases and in particular to improve the vaccine now employed for the control of Blackquarter, the mortality from which is still high.

Anthrax continued to be a serious source of loss in many parts of India, but a spore vaccine, made by the Civil Veterinary Department in Burma, was employed in that country and in various Indian Provinces and States with very satisfactory results. In Burma this vaccine proved particularly successful in preventing Anthrax in elephants, and in India it has been very satisfactorily employed to control the incidence of Anthrax among horses and cattle.

During the period under review, a very great deal of information was obtained by Veterinary Investigation Officers in provinces. In particular, the cause of a heavy mortality among cattle in various parts of India was found to be due to bovine surra. It is now clear from these investigations that this condition is widespread during and after the rains, but that with suitable treatment mortality from this cause can easily be controlled. Further extensive

observations were made during the year on the incidence and treatment of schistosomiasis and other parasitic diseases of live-stock of different kinds and systematic recording was continued of entozoal and other parasites of live-stock. Much valuable information was also obtained as to the effects of such parasites and as to the possibilities of control under Indian conditions. Systematic investigation of stock-diseases in Provinces and States also brought to light a number of areas in which mineral deficiencies are the cause of marked degeneration and in some cases of mortality among live-stock of various kinds.

Investigations were made, as opportunity offered, of the diseases of sheep, goats and poultry and showed that a great deal more attention should be paid to the diseases of these classes of stock than has hitherto been possible. The diseases of poultry, in particular, are a very serious deterrent to the development of a very important cottage industry in India and arrangements have been made, under a grant from the Imperial Council of Agricultural Research, for a specialist research worker to be employed for a term of years for systematic research on poultry diseases.

Valuable information regarding the diseases of sheep and goats was also obtained from the experimental flocks which are now maintained at certain Government farms, under grants from the Imperial Council of Agricultural Research, but a great deal more systematic investigation and research is required into the diseases of these animals, since up to the present they have seldom been reported by their owners, many of whom are nomadic in their habits.

At the MUKTESAR RESEARCH INSTITUTE, further studies were made on the viability of goat virus outside the animal body and on the duration of immunity after goat-virus vaccination, while further progress was made on the production of a highly potent anti-rinderpest serum.

Research was continued on Strangles, in collaboration with the Army Veterinary authorities, the disease being carried on by artificial infection with living cultures of the strangles streptococcus, but attempts to produce a milder form of the disease or to cure it by drugs or serum proved unsuccessful. The causative organism

of a fatal form of Pneumonia in foals was, however, isolated and some progress was made in regard to the development of a practical method of controlling Ranikhet disease of fowls.

Further research on the condition of Blindness in calves, which was mentioned in last year's review, confirmed the previous finding that this condition is due to a nutritional deficiency closely associated with a lack of Vitamin A in the diet. Research on Osteomalacia of cattle, which has now been found by Veterinary Investigation Officers to exist over large sections of the country, showed that this condition was due to aphosphorosis and that bone-meal feeding was of value in the treatment of affected animals.

Further research on Johne's disease failed to demonstrate that the causative organism was excreted in the milk of infected animals or that intra-uterine transmission takes place. Advanced lesions of Johne's disease were, however, found in the carcasses of two calves which had been subjected at birth to the prophylactic vaccination mentioned in the last report and a case of Johne's disease was detected in a bull purchased from the interior of Garhwal hills where the possibility of contracting this infection from animals imported from overseas is very remote. This observation is of interest in relation to the probable source of this disease in India.

A peculiar disease resembling Epizootic Lymphangitis, but not due to a cryptococcus, was investigated and further studies on Enzootic Bovine Hæmaturia have led to the isolation of a yeast-like organism (blastomyces), the significance of which is being investigated.

In the Helminthology Section, a distressing form of Ophthalmia, common in horses in northern India, was investigated and was found to be caused by a microfilaria inhabiting the tissues of the eye and the lachrymal glands and further research was carried on to endeavour to identify the adult form of this parasite and also those of Hump Sore in cattle and of Lichen Tropicus in horses, both of which conditions have been shown in recent years to be due to microfilariæ.

In the Protozoology Section, research was made into the fatal outbreaks of bovine Surra which were mentioned in last year's

report. At that time this condition had been detected in Hyderabad State and the Punjab only, but, during the year, similar outbreaks were detected by Veterinary Investigation Officers in Bombay, the Central Provinces, Gwalior and Assam, and it is clear that this condition is widespread and of great economic importance. Research is now being carried on to determine whether the causative organism of this condition is the same as that of equine Surra.

Trypanblue having proved disappointing in the treatment of cases of Red water of cattle due to *Babesia bigemina*, tests were carried out with a number of new proprietary preparations one of which has proved highly successful as a curative, though valueless as a prophylactic. In regard to Theileriasis of cattle, which was referred to in last year's report, observations were carried out to determine the optimum point at which to bleed for the production of a potent serum and it was found that the stage at which the parasites disappear from the blood gave the best result. A variety of drugs were tested for the treatment of Canine Piroplasmosis due to *B. gibsoni*, but with none was complete sterilization achieved.

In the Entomology Section numerous experiments were carried out on the transmissibility of Fowl-pox and Rinderpest by means of certain biting flies, with negative results, except in one case of Rinderpest, and for the first time the presence in India of the Spinose Ear Tick (*Ornithodorus megnini*) was demonstrated in material collected from the ears of an Australian army horse. This parasite is well known to occur in America and it is possible that it may have been originally imported into India by mules or horses imported from that country. The observation is important since the Spinose ear tick attacks human beings in the United States of America with very serious results. Numerous studies were carried out on the life-history of insects and further observations were made upon the morphology of the mouth-parts of ticks.

In MADRAS special attention was paid to the contagious diseases of sheep and goats, which annually cause heavy loss in the Presidency, but on which hitherto little research has been carried out.

In particular, attention was paid to a fatal form of Pneumonia which is reported to cause heavy mortality among goats. Observations were also made on the distribution of Schistosomiasis in cattle and its treatment.

In the PUNJAB field observations were carried out on the control of Warble infestation in cattle and of Foot-and-mouth disease by means of medicated licks and foot-baths. At the Punjab Veterinary College, the causative organism of calf Septicæmia was definitely determined and the results published. The pathology of a local disease of buffaloes, known as *deg* disease, was also investigated, and field experimentation, on a considerable scale, was carried out in regard to the prophylaxis and treatment of equine Surra. These observations, which have been confirmed in the UNITED PROVINCES, indicate that this disease can readily be controlled by medicinal treatment provided that treatment is undertaken before the paralytic stage has been reached and that the animals are well cared for during treatment. Field observations were also made on the prophylaxis of Surra in camels and a considerable amount of research was carried out in regard to equine Encephalo-myelitis and the immunisation of dogs against Rabies.

In the BOMBAY PRESIDENCY observations were continued as to the viability of goat virus as a vaccine against Rinderpest and on the duration of immunity conferred by it. The incidence of contagious bovine abortion and bovine sterility were also studied and extensive observations were made on various protozoon diseases, which in this part of India are responsible for a great deal of sickness and mortality.

In BIHAR also extensive observations were made by the Veterinary Investigation Officer on the field use of goat-virus vaccine as a prophylactic and for the control of outbreaks. At the Patna Veterinary College further observations were made and published on the histopathology of *kumri*. Experiments were also carried out in the treatment of Nematode infestations of cattle, with carbon tetrachloride and other drugs. In the course of this work, a number of cases of Coccidiosis were found to occur, and investigations were started with a view to developing a suitable method

of control of this condition, which in the wetter parts of the country is a serious cause of sickness and mortality, particularly among buffalo calves.

2. Animal nutrition

The Physiological Chemist in charge of the Animal Nutrition Section, Bangalore, was able to complete some interesting experiments during the year. That dealing with the mineral requirements of growing calves showed that when calcium and phosphorus were present in sufficient quantity in the food itself, the introduction of a calcium phosphate supplement did not influence the live-weight of the calves in any way.

Two experiments with dairy cows were carried out, one to determine the effect of high protein feeding, which showed that the milk-yield was not affected. The other was to study the effect of feeding vegetable oils on the fat-content of milk and the quality of butter. The results showed that there was no effect on the fat-percentage of the milk, but the butter displayed marked differences in its chemical and physical properties.

Work was continued on Sulphur metabolism and Fat metabolism, the latter bringing to light the important fact that the available methods for the determination of fat in biological material are unsuitable for a quantitative study of fat metabolism in cattle.

In MADRAS, work under the scheme financed by the Imperial Council of Agricultural Research included a survey of grasses in North Malabar district which disclosed marked deficiencies in both calcium and phosphorus, especially the latter. Sulphur-feeding to sheep did not result either in increase in wool-weight or increased sulphur-content of the wool. Work on the sulphur metabolism of sheep has, therefore, been taken up.

In BENGAL, another Council's scheme received impetus by the addition of two Assistants to the staff. Analyses and feeding experiments were carried out with water-hyacinth (*Eichhornia crassipes*) and Napier Grass at Rangpur and with *aman* (winter) paddy straw and linseed cake at Dacca. The amount of rice-bran available annually in Bengal is estimated at thirty-two million

maunds and it has a reputation as an article of high feeding value. Special attention was, therefore, given to a feeding experiment with *aman* straw and rice-bran. The rice *kura* used in the experiment had an oil-content of twenty per cent, and its mineral composition was high, but the animals fed on this mixture did not thrive and the reasons for this are under investigation.

In the PUNJAB, the comparative feeding values of green *bajra* (*Pennisetum typhoideum*), *bajra* hay, oat hay, and *guara* (*Cyamopsis psoraloides*) silage were investigated at the Lyallpur Agricultural College and these were all found to constitute a maintenance ration. In BIHAR, a mineral-feeding experiment with the dairy animals at the Kanke Farm was commenced during the year.

CHAPTER VIII

VETERINARY EDUCATION AND OTHER COURSES

1. Veterinary colleges

In the previous review, mention was made of the insufficiency of the provision for veterinary education of the highest standard in India, such as would secure international recognition and equip young Indians for appointment to the Superior Provincial Veterinary Services.

As a preliminary step for improving the standard of veterinary education, a suitable uniform curriculum for all Veterinary Colleges in India was framed and recommended to the provinces concerned for acceptance. This is required to be supplemented, however, by some means for imparting higher training in veterinary science, if the desired result is to be achieved. The question of implementing the recommendations of the Royal Commission on Agriculture on this subject was again investigated and some preliminary enquiries made, with the result that a proposal has been made for the establishment of a Central Veterinary College in which the course of instruction will be of five years' duration and the syllabus practically the same as that for the M. R. C. V. S. course in the United Kingdom. Provincial Veterinary Colleges are to be affiliated to the Central College under certain conditions and it is hoped to be able to obtain the recognition of the Royal College of Veterinary Surgeons for the central institution.

Punjab Veterinary College. During the academic year 1935-36, 117 applicants offered themselves for admission to the four years' course leading to the Diploma of Licensed Veterinary Practitioner, and of these fifty-six secured admission. The number of students on the rolls at the end of the year was eighty-five, and the number of students who passed the final examination was twenty-one.

Of the other courses offered by the college, twenty-one students joined the Farriers' class, eight of these taking the course for cold

shoeing. Two practical courses for syces were held at the Government Cattle Farm, Hissar, in May and November 1935. A Dressers' class was held as usual and twenty-one candidates completed the training.

BOMBAY VETERINARY COLLEGE. Forty new students were admitted into this college in class A during 1935-36. The total number on the rolls at the end of the year was 103, as against ninety-three in the previous year. Of the 103 students, forty held stipends and sixty-three were private students. Fifteen students were declared successful in the final examination.

Of the sixty-two graduates who passed out of the college during 1933-35, forty-three are reported to be in the service of Government or local bodies, twelve in the service of States, five are unemployed and two have died. All who passed out in 1935-36 have secured appointments.

The college conducted an examination for the issue of licenses to farriers, in accordance with the provisions of the Bombay City Municipal Act. All the five candidates who appeared at this examination were declared successful and were granted the necessary certificates.

MADRAS VETERINARY COLLEGE. This college has been recognised by the University of Madras as a constituent college of the University for imparting instruction for the Degree of Bachelor of Veterinary Science. Arrangements have been made for introducing the Degree course from the academic year 1936-37

Under Government orders, the number of students admitted to this college was restricted to thirty during 1935-36 : out of these, ten vacancies were thrown open to outside students including those from Burma. The actual admissions during the year numbered thirty-one (20 from Madras Presidency, 1 from the Federated Malay States and 10 from Burma). The total strength of the college was ninety-six at the end of the year, as against 107 in the previous year. In all twenty-nine students passed out of the college during the year.

A candidate from Cochin State was given training in Farriery at the college for three months.

A scheme for the establishment of a model dairy at the college has been submitted to Government and is expected to materialize shortly.

BENGAL VETERINARY COLLEGE. During the last few years there has been an increasing demand for admission into this college. The number of students on the rolls during 1935-36 was 174, as against 170 during the preceding year. Of these 174 students, fifty-eight held stipends from various bodies and the rest were private students. Fifty-six students were admitted into class A, and six took admission from the Bombay Veterinary College to classes C and B. Five old students of B and C classes of the college were re-admitted during the year. The total number of those who graduated during 1935-36 was forty-two.

In addition, a number of short courses were arranged as usual. Two soldiers from the Military Department completed a short course of training for six months each in veterinary subjects. Six non-commissioned officers from the Burma Military Police attended the Farriers' course. The Dressers' course was attended by seventeen non-commissioned officers from the Burma Military Police, four from the Assam Rifles and one from Bonai State (Orissa). A Veterinary Dispensing course and a Riding School were also conducted.

BIHAR AND ORISSA VETERINARY COLLEGE. During the period under review, thirty-six new students joined the college, as against twenty-five in the preceding session. The total number on the rolls at the end of the session was sixty-four, of whom thirty-eight were private students and twenty-six held stipends. Out of nine students who passed the Diploma examination, four gained distinctions. The syllabus of the college was revised during the year.

INSEIN VETERINARY COLLEGE. The second batch of students taking the one year's course for the new grade of Veterinary Assistant completed their training in December 1935. Of the sixteen original students, thirteen graduated during the year and eleven of them secured appointments. A third batch of fourteen students commenced their training on the 4th November 1935.

A second batch of ten students were selected and deputed for training at the Madras Veterinary College. It is anticipated that a third batch of eight students will be selected for training during the ensuing year to fill vacancies for District Inspectors' grade.

To commemorate the memory of Colonel G. H. Evans, late Superintendent, Civil Veterinary Department, Burma, a gold medal, designated the ' Evans Memorial Prize ', has been instituted for presentation to the student who secures the first place in the college examinations.

2. The Indian dairy diploma

Out of the twenty-one students who appeared for the Indian Dairy Diploma examination at Bangalore in December 1935 seventeen passed the final examination. During the year a new batch of twenty-four students was admitted to this course and are now under training at Bangalore.

A class was held for this diploma at the ALLAHABAD AGRICULTURAL INSTITUTE also during the year under review, and at the final examination six passed out of the nine who appeared.

3. Post-graduate courses

The annual post-graduate refresher course at the IMPERIAL VETERINARY RESEARCH INSTITUTE, MUKTESAR, was held from the 8th April to the 6th July 1935 and twelve officers attended the course. Three of these continued to receive training at the Institute for a further period of about three months and a fourth for about four months. One officer from Iraq, after completing the post-graduate course, remained at the Institute up to the 17th November 1935 to complete the balance of one year's training for which he had been deputed to the Institute by the Iraq Government. Another officer from Iraq reported on the 2nd January 1936 for one year's training. One research scholar from the PUNJAB remained at the Institute throughout the year.

In addition to the post-graduate refresher course, short courses of practical training were given at the Institute to seven officers.

Major F. J. Andrews, B.Sc., R.A.V.C., spent four months at this Institute in connection with the investigation of Strangles amongst army horses.

At the PUNJAB VETERINARY COLLEGE, one candidate from the Bombay Presidency completed the refresher course in Pathology, Parasitology, Bacteriology and Meat and Milk Inspection.

At the MADRAS VETERINARY COLLEGE, a revised nine months' refresher course for Veterinary Assistant Surgeons was introduced from July 1935, and six Veterinary Assistant Surgeons from the Department and two Veterinary Inspectors from H. E. H. the Nizam's Government attended the course.

The post-graduate training class at the BIHAR AND ORISSA VETERINARY COLLEGE at Patna, which was suspended for one year, was re-opened with a shorter course of three months, and nine students attended the course.

At the INSEIN VETERINARY COLLEGE, a refresher course of three months' duration for Veterinary Inspectors and Veterinary Assistants was held from January to March 1936. Three Veterinary Inspectors and eight Veterinary Assistants attended the course.

One post-graduate student, who was admitted for a course in Animal Husbandry and Dairying at the IMPERIAL DAIRY INSTITUTE, BANGALORE, in January 1935, completed his training in March 1936, and five more post-graduate students were admitted for a similar course of study on 2nd January 1936.

Eight students took short courses of practical training at Bangalore for periods varying from two to seven months, and thirteen British soldiers completed a vocational training course in September 1935. Another twelve British soldiers were admitted to this course in March 1936.

CHAPTER IX

DISTRICT WORK

THE year under report witnessed an event of the greatest importance to agricultural extension work in India, *viz.*, the initiation of an all-India drive towards Rural Reconstruction. This was rendered possible by the grant of a crore of rupees by the Central Government to provinces and minor administrations for expenditure on approved schemes of economic development and improvement of the rural areas. This amount was divided among the various provinces on a population basis, and utilised to carry out practical rural uplift schemes. These were spread in many cases over a period of years, and were designed to improve not only the actual money income of the cultivators but also their health, education and morale. Agricultural improvement work in the villages naturally claimed a fair share of the various provincial allotments, and as a result, the Agricultural Departments in all provinces were able to extend and intensify their propaganda and also activities connected with supply of seed, manures and implements.

The figures given in the preceding chapters illustrate the extent to which improved crops and other agricultural improvements have been introduced and have become part of the general agricultural practice of the country—a result which has been achieved by well-organised and persistent propaganda and demonstration. In this chapter a brief account will be given of the principal methods of propaganda employed in the different provinces and of any changes during the year. Progress in the introduction of new crops can be judged to some extent from the fact that the ascertained area under such crops was over 21·4 million acres as compared to 18·6 million acres in 1934-35. Progress in the introduction of improved implements and manures is much more difficult to gauge, since the sales by and through departmental agency represent only a fraction of the total sales. To form any real estimate of the extent to which improved methods of cultivation have been taken up is still more difficult. But more important than the introduction of

any single improvement, is the gradual change in the outlook of the cultivator and his growing recognition of the possibility of raising the efficiency of his agriculture by the application of new methods. In the words of His Excellency the Viceroy, at the opening meeting of the Advisory Board of the Imperial Council of Agricultural Research in July 1936, " There can be no doubt that public interest in agricultural improvement is everywhere increasing and I am informed by experienced officers that the readiness to receive expert advice now-a-days displayed by the cultivators is in marked contrast to the indifference shown but a few years ago in many areas towards the ministrations of the agricultural officer ". The reports from all provinces and States bear ample testimony to this welcome change in the outlook of the cultivating classes.

1. Demonstrations

The ocular demonstration of an agricultural improvement on the cultivators' own land, under village conditions, still continues to be the most efficient and reliable form of propaganda. In all provinces the departments have a large number of improved practices ripe for demonstration, and the problem facing them has been the evolution of an organisation by which a great part of the province can be covered by such improvements in a reasonable time and without incurring prohibitive expenditure. The solution of the problem has been attempted in different ways in different provinces, and the ' Rural Uplift Grant ' of the Central Government has enabled every province to launch on schemes of concentrated demonstration and propaganda in the villages.

In MADRAS, further progress was made with the system of concentrating the demonstrations in a definite number of villages. The modification which was introduced last year, *viz.*, the slow extension of the demonstrators' activities from one central village to a larger number of central villages was continued during the year, with the result that the number of demonstration plots increased from 3,170 in 1934-35 to 7,214 during the year, and the effect of the demonstrations was felt over a wider area. The plots were organized mostly

to demonstrate varietal, cultural and manurial improvements on paddy, sugarcane, *ragi*, groundnut and fruit. For an intensive development of demonstration work in villages, a scheme for the appointment of sixty-three demonstration *maistries* for a period of five years was sanctioned by Government as an experimental measure. The scheme was worked in the first instance in nine taluqs of the Vizagapatam district. With a view to improving the general condition of the villagers, these demonstration *maistries* were also trained to persuade villagers to keep their houses and streets clean, start village improvement associations, etc.

In BOMBAY the Department organised 2,300 demonstrations as against 1,754 in the previous year, and these aimed at educating the cultivators to adopt special items of agricultural improvement. With the help of the Central Government grant for rural uplift, a 3-5 year programme of rural uplift work was put into operation and work concentrated on the supply of improved seed, cane sets, bunding, improvement of poultry, improvement of sheep-breeding, conservation of farmyard manure, establishment of fruit nurseries, etc. The Department maintained a Shikar Officer for the protection of crops against wild animals and he organised a series of gun-clubs whose controlled activities reduced the ravages of this pest to a marked extent. Under the Indian Central Cotton Committee's Plant-Puller Propaganda Scheme (against the Spotted Boll-worm of cotton) vigorous propaganda was carried out in Surat and Broach districts, where the areas of cotton stumps up-rooted totalled 56,000 acres and 143,296 acres respectively.

In BENGAL, the number of demonstrations given during the year was 4,569 as against 3,510 in the previous year. Intensive propaganda was again undertaken to induce cultivators to reduce the area under jute and fifty additional demonstrators were employed for four months in connection with the introduction of *rabi* crops and substitute crops for jute. With the help of the Central Government grant for rural uplift, arrangements were made for the establishment of a number of small demonstration farms and seed-multiplication areas in Union Boards within the jurisdiction of an agricultural demonstrator, with a view to concentrated work in selected

areas. It is hoped that the funds provided will, for the first time in the history of this department, enable concentrated work to be done, and provide a nucleus for the extension of improved seeds and methods within the Union Boards benefiting from the scheme. The increasing number of private farms run on model lines provided once again an effective means of popularising modern methods.

UNITED PROVINCES. The total number of practical demonstrations carried out during the year was 12,642 as against 10,376 in 1934-35, and the area affected by the demonstrations increased to 113,171 acres from 85,890 acres in 1934-35.

Two developments are reported in the scheme followed for the concentration of demonstrations. One was the organising of demonstrations on a group of fields on which the different improvements are demonstrated simultaneously, thus enabling the cultivators to appreciate a number of improvements individually displayed. This system was being followed in rural development centres in which intensive effort is expected to lead to a rapid adoption of agricultural improvements. The other development was a remodelling of the cultivator's holdings, combined with the block-sowings of crops. This was an outcome of the agricultural development of the areas irrigated from State tube-wells. Under it the cultivators are induced to straighten all field-boundaries, to construct straight water-channels and to arrange their plantings in defined blocks of one crop instead of scattered patches. The advantages of consolidation of holdings are thus obtained without the delays and difficulties attendant upon re-distribution of fields. The results of both these developments are reported to have been satisfactory.

In the PUNJAB, the number of demonstration plots laid down on cultivators' fields was 3,309. A number of campaigns against various insect pests and crop diseases were carried out with great success; campaigns agaist *pohli* eradication and rat destruction were also launched in some districts. The Divisional Ploughing Competition was held in Jullundur during the Farmer's week. The contest was very keen and the standard of ploughing exhibited was of a high order. The system of reserving one rectangle in each of twenty villages in the Nili Bar Colony for allotment in half-rectangle

grants to those cultivators who farm their holdings best in the year was continued. The scheme is reported to be proving effective in bringing about the rapid propagation of improved methods of cultivation in the Colony.

In BURMA, the number of demonstrations conducted on the cultivators' own fields totalled 2,163 as compared to 2,182 in 1934-35. In Lower Burma, these demonstrations were chiefly concerned with improved varieties of paddy and manures, while in Upper Burma they were concerned with improved methods of cultivation and new crops. Under the Indian Central Cotton Committee's scheme for the improvement of the cotton areas of the *wagale* tract, twenty-four demonstrators were in charge of seventy-one demonstration holdings in four cotton districts, and these holdings, which were run on model lines, are reported to be producing a conspicuous effect in the neighbourhood. During the year under report the average yield for these demonstration holdings exceeded the local average by thirty-nine to forty-seven per cent; also the drill-sown area, the number of seed-drills and bullock cultivators in use, the number of cultivators conserving manure and the area under improved lay-out have improved considerably since 1931 when the scheme was started.

BIHAR AND ORISSA. The number of overseers and *kamdars* employed by the Department during 1935-36 was fifty-four and 135 respectively, against forty-eight and 105 in the previous year. The total number of field demonstrations carried out was 13,860. Although this number was slightly less than in the previous year, the effective spread of improvements is reported to have been very much greater.

The Byreah Farm owned and financed by the Bettiah Wards Estate and the farms at Lalsaraiya and Madhopur were run efficiently and served as object-lessons in large-scale farming on modern lines. The annual balance sheets of these farms showed a return of eleven per cent on the total investment at the Byreah Farm and sixteen per cent at the other two farms. By the working of these farms the department could claim to have demonstrated that farming on modern methods can be made to pay handsomely.

In the CENTRAL PROVINCES, the department carried out 8,053 practical demonstrations as against 6,234 in 1934-35. As usual, a number of demonstration plots were worked, some by the department on rented land, and others by the cultivators themselves under the direct supervision of the department. The general policy of the department is to encourage private demonstration plots as far as possible and to use Government plots for specific purposes only. Thirty special private plots were located under the Kharung and Maniari reservoirs to demonstrate the effect of irrigating paddy and all of them yielded substantial profits.

In ASSAM the practical demonstrations carried out by the Department totalled 2,170, as compared with 3,258 in 1934-35. The most important feature of the year was the demonstrations on growing *boro* paddy (transplanted spring rice) on areas liable to flood, under power-pump irrigation. The Government allotted Rs. 20,000 from the Rural Uplift Grant of the Central Government for the purchase of ten power-pumps for this purpose. Though the demonstrations were not financially successful, it confirmed the result, obtained at the first trial at Habiganj, that *boro* paddy could be grown profitably with the help of power-driven pumps and that a large part of the area now lying fallow could be brought under cultivation. Successful demonstrations with improved varieties of sugarcane (POJ 2714, 2878 and 1507 and Co 290 and 213) were continued mainly in the Assam Valley. An intensive campaign for the eradication of water-hyacinth was conducted in the Surma Valley. In the Khasi and Jaintia hills, the demonstrations were mainly concerned with manures and potatoes. The jute-restriction campaign resulted in a substantial decrease of the acreage under jute and seed of substitute crops like sugarcane and *rabi* crops was sold to cultivators at half price.

In SIND, the district demonstration and propaganda work was completely overhauled and the district staff strengthened during the year. As at present organised, the work is carried on under eleven territorial divisions, each in charge of an Inspector of Agriculture assisted by one or two assistants and a small staff of *kamgars*. The number of demonstrations carried out was 814 as against 666

in the previous year. To ensure the development of propaganda in close touch with the actual requirements of the cultivators in different tracts, the formation of district agricultural committees is contemplated. Under the Indian Central Cotton Committee's Cotton-seed Distribution and Extension Scheme for the Barrage areas, intensive propaganda was continued both on the Right and Left Banks of the Indus. Forty cotton demonstration plots were laid out on the Right Bank of the Indus and in most cases the departmental variety gave better yields than the local.

The six Auxiliary Farms are becoming valuable centres for propaganda and demonstration work.

In HYDERABAD the number of practical demonstrations carried out by the Department during the year was 2,649 as compared with 1,911 in 1934-35. In addition there were fourteen aided farms under the supervision of the department which were used as permanent centres of demonstration and propaganda.

In MYSORE the number of demonstrations carried out by the Department was 900, the demonstration plots being arranged in 209 places, 134 showing the use of manures and the rest the use of improved seeds.

In BARODA the district propaganda work will in future be based on the concentration of activities in certain blocks of villages, the rest of the tract being served by itinerant units. Arrangements are being made to train men for concentration units, of which ten will function shortly. The Rural Reconstruction Centre at Kosambi in the Navasari district showed considerable activity during the year. Under the Indian Central Cotton Committee's Plant-puller Propaganda Scheme, vigorous propaganda was undertaken in Navasari and Baroda districts and 3,577 pullers were sold.

In TRAVANCORE eighty-five demonstrations on paddy and 102 demonstrations on coconut were conducted during the year.

In COCHIN demonstrations on paddy cultivation were given at twenty-nine centres, on sugarcane at nine centres and on coconut trees at sixteen centres. Advice and help were given to ryots in matters relating to drainage and irrigation, improved seed and implements, the use of fertilizers and control of pests and diseases.

2. Other forms of propaganda

From year to year the propaganda work conducted by agricultural departments improves in technique. In addition to the older methods of demonstration plots, shows and exhibitions, bulletins, leaflets and lectures, which still continue to figure in an increasing measure, there are now in use, the cinema, the radio and the gramophone, all of which are being utilised in one or more of the provinces with a considerable degree of success. In addition, in many provinces there are in use demonstration vans containing a large selection of propaganda material and usually cinema or other projection outfits. These mobile units sow the good seed in many out-of-the-way places—seed which must be watered and cultivated by the district staffs following up with further advice.

In MADRAS, the three motor exhibition vans toured throughout the Presidency, except in the first and second circles and the Niligiri district.

In BOMBAY, a semi-private agency has been experimenting with the making of gramophone records, chiefly in Marathi, dealing with the agricultural and rural propaganda and a demonstration motor van is in action.

In the CENTRAL PROVINCES, the demonstration lorry covered 1,314 miles and gave 76 shows.

In the UNITED PROVINCES, propaganda by departmental kiosks fitted with exhibits of produce and implements, and with descriptive charts and photographs and erected at important railway stations, proved very effective. Two additional kiosks were provided at Jhansi and Cawnpore stations. Those with sign-boards and posters also exhibited at railway stations are reported to have brought in many enquiries. Extensive arrangements for the display of further posters is being made and posters have been supplied for display in important market places and at district and *tehsil* headquarters.

The utilisation of posters is making slow progress since posters require rather careful designing. Certain of the Indian Central Cotton Committee's posters have been definitely successful, one

very striking poster being designed and employed for the anti-*Goghari* campaign in Gujarat.

3. Agricultural shows and exhibitions

Agricultural shows and exhibitions continued to be held in all provinces and States and varied considerably in size and scope.

In MADRAS, exhibitions and shows were held on occasions like cattle fairs, Jamabandi camps, health week celebrations and district co-operative conference. The number so held during the year was 195 as against 178 of the previous year. At the *Ekadasi* festival day at Srirangam, when thousands of people congregated, a large-scale exhibition was staged, which included a model farm house, improved cattle-shed, manure pits, dairy, poultry and apiary, an orchard of properly-spaced fruit trees and demonstrations connected with the cultivation of sugarcane and manufacture of sugar. At an exhibition held at Nellore, crops of educative and economic value were grown in small seed-beds. Two thousand and eight hundred and forty-five lectures were delivered with and without the aid of the magic lantern during the various exhibitions.

In BOMBAY, ten shows were held during the year. Many of these were on a fairly large scale, comprising sections of agriculture, horticulture, poultry, cattle, forestry, veterinary, co-operation and rural uplift, and attended by thousands of visitors.

IN BENGAL, the funds available for contributions to exhibitions were too limited to enable the department to participate fully, still a good number of shows were organised in the districts. Of the exhibitions in which the department participated, the best value was obtained from those held at Jaidebpur and Kalimpong.

In the UNITED PROVINCES, one first class show and an average of five second class shows were held in each circle during the year, while a larger number of smaller shows and fairs were utilized for agricultural displays and competitions. The agricultural demonstration carts continued to do very good work in touring the remoter villages.

In the PUNJAB, Farmer's Weeks were held at all the departmental farms and large numbers of exhibits were set up and

demonstrations given on these occasions. The Jullundur Week attracted over 9,000 visitors from all over the circle.

In BURMA, ten shows were held during the year. A fine array of agricultural and horticultural exhibits was displayed at the Arts and Crafts Exhibition held at the Jubilee Hall, Rangoon, and at the All-Burma Industrial and Agricultural Exhibition held at Moulmein.

In BIHAR AND ORISSA, the department participated in all important fairs and *melas* and assisted these with grants. Two important exhibitions were held during the year at Patna, *viz.*, the Bihar and Orissa Agricultural and Industrial Exhibition and the Bihar and Orissa Mango Exhibition, and both attracted considerable attention.

In the CENTRAL PROVINCES, 107 shows were arranged during the year as against sixty-four of the previous year. Farmer's Days were held on many of the Government farms and demonstration plots, which attracted large numbers of cultivators.

In ASSAM, the department participated in eleven exhibitions. The one held at Indeswar in South Sylhet was very successful both as regards the variety of exhibits and the attendance.

In SIND agricultural shows were held at fifteen centres ; a show held at Pithoro attracted over 70,000 cultivators. A horticultural section was arranged at each show and attracted much attention. The touring propaganda party, equipped with a magic lantern, visited about sixty centres and also attended all important fairs. Farmer's Weeks were organised on all the Government Auxiliary Farms.

In HYDERABAD, a rural development exhibition was held at Patancheri in connection with the rural development centre. Forty-seven other shows were held during the year.

A ' Rural Life ' exhibition was organised at BARODA on the occasion of the Diamond Jubilee celebrations of H. H. the Maharaja of Baroda and represented a true picture of the agricultural, commercial and industrial development in that part of the country. The Exhibition attracted thousands of visitors, farmers, merchants and manufacturers. The Publicity Department of the Indian

Central Cotton Committee also participated in the Exhibition and an attractive collection of instructive cotton exhibits was displayed.

In TRAVANCORE, several agricultural and industrial exhibitions were held, the most important one being that arranged in connection with the Birth Day celebrations of His Highness the Maharaja.

4. Agricultural associations

The co-operative movement in relation to agriculture forms the subject matter of a separate chapter. Here mention is made of other kinds of non-official bodies which play an increasing part in the agricultural extension work of provinces and States.

In MADRAS a number of District Agricultural Associations interested themselves in agricultural improvement. One new agricultural association and twenty-two village improvement associations were started in the I circle and forty-five *firka* associations in the II circle.

In BOMBAY, ninety-six Taluka Development Associations were subsidised by the department, of which twenty-five had been newly formed during the year. The total amount of subsidies granted was Rs. 43,492. Of the seventy-one old associations, thirty have been classed by the Divisional Boards of Agriculture as very successful. Many of these associations enthusiastically co-operated with the department in agricultural extension work. The Deccan Agricultural Association undertook pig destruction work on a large scale, and continued the publication of its Marathi Agricultural magazine " Shetki and Shetkari ". A Gujarati and a Kanarese agricultural journal also get good support.

In BENGAL, owing to financial stringency it was not found possible to renew the grants to agricultural associations, whose activities were therefore somewhat restricted. Among the associations which carried on good work even under this handicap, mention is made of those at Midnapore, Hooghly, Howrah, Burdwan, Murshidabad and Bogra. A large number of District and Union Boards, as well as Khas Mahals and Court of Wards Estates, took

considerable interest in agricultural work and provided funds for improved seed, demonstrations, etc.

In the UNITED PROVINCES, a large number of better-farming and better-living societies in the Eastern circle lent a helping hand to the department in the distribution of improved seed and implements. The Allahabad Agricultural Association rendered valuable help through its *Magh Mela* demonstration plot and the *Ardh Kumbha* Exhibition which it organised. Agricultural talks broadcast from the Agricultural Institute, Naini and from the Swadeshi Exhibition were an interesting feature of non-departmental activity in this province.

In the PUNJAB there were 2,600 Village Farmers' Associations which were run by the Agricultural Department and these embraced all phases of village uplift. A large number of these have started their own model farms.

In BURMA three District Agricultural Societies are mentioned as having arranged for demonstrations and assisted in the supply of improved seeds and implements.

In BIHAR AND ORISSA, the Provincial Agricultural Association continued to assist the department, and the Association's Hindi Journal—*Kisan*—was widely appreciated. A number of Central Banks actively co-operated with the department in demonstrating improved methods of cultivation to their members.

In the CENTRAL PROVINCES, the reorganization of the Tahsil Agricultural Associations in the Eastern circle is reported to have made them more active.

In ASSAM, the honorary correspondents, of which there were 115, gave considerable assistance in carrying out experiments in growing improved seeds and in popularising modern methods among the cultivators.

In HYDERABAD, the Hyderabad Farming Association, with which the Hyderabad Poultry Association has been amalgamated, continued to do useful work and its quarterly magazine, *The Hyderabad Farmer*, was an important medium for agricultural propaganda.

In MYSORE, the Agricultural and Experimental Union gave considerable assistance to the department and continued to publish its English and Kannada journals.

5. Seed multiplication and distribution

Arrangements for the production and multiplication of seed of improved crops have been extended and improved in several provinces.

The Indian Central Cotton Committee continued its policy of helping agricultural departments and co-operative sale societies in the more extended distribution of pure seed of improved varieties of cotton. Twenty Seed-distribution and Extension Schemes have so far been sanctioned by that Committee, of which seventeen were in operation during the year.

The Imperial Agricultural Research Institute continued the supply to provincial departments of seed of improved varieties of crops evolved at the Institute. The demand for such seed exceeded the available supply in many cases. For Pusa 4 wheat alone, indents totalling 103,731 lbs. were received during the year. This wheat was particularly popular in the Bombay Presidency and the Deccan. In the Jullundur Circle of the Punjab, there was a growing demand for seed of Pusa 80-5.

In MADRAS, good progress is reported in the spread of improved strains of crops. Besides the production of seed directly by the department, large areas of seed-farms on ryot's land under departmental supervision were arranged as usual. Special attention was paid to paddy, cotton, groundnut and sugarcane, the quantities distributed during the year amounting to 2,479 tons, 1,580,372 lbs., 11,171 lbs. and 1,241,296 setts respectively. Under the Co 2 Cotton-seed Multiplication Scheme, financed by the Indian Central Cotton Committee and run in conjunction with the Thiruppur Co-operative Trading Society, 5,320 acres of seed-farms were arranged and over 10 lakhs lbs. of good-quality seed sold to ryots.

In BOMBAY, seven cotton seed extension schemes, subsidised by the Indian Central Cotton Committee, were in operation during the year. The Hubli, Athani and the Gadag schemes, which have

for their object the spread of Jayawant and Gadag No. 1 cottons in the Southern Division of the province, have merged in a comprehensive revised Jayawant and Gadag No. 1 scheme, sanctioned by the Indian Central Cotton Committee. This revised scheme, which came into operation in June 1936, is intended to cover about 7¾ lakhs acres under Jayawant cotton and 1¾ lakhs acres under Gadag No. 1, and will be operated from nine centres in the tracts concerned. The total amount of cotton seed distributed under all the seven schemes referred to above, amounted to over forty lakhs of lbs. and the area under improved cottons in Bombay has risen from 617,224 acres in 1934-35 to 692,617 acres during the year under report. The departmental arrangements for the distribution of improved varieties of rice, wheat and *nagli*, through the help of registered seed-growers, were continued and the total amounts of seed of these crops distributed to ryots amounted to over 3·5 lakhs lbs. The distribution of improved sugarcane varieties was arranged on a large scale in the Deccan Canals area, where the area under sugarcane is now 30,000 acres, nearly sixty-three per cent of the area being under improved varieties. Seed production on private farms is on the increase, especially in Nasik and Khandesh. The owners of these farms give certain undertakings and receive certain help and inspection.

In BENGAL, in connection with the intensive campaign for the restriction of the area under jute, the Government sanctioned Rs. 15,500 to meet the cost of sugarcane cuttings supplied to cultivators to encourage the cultivation of sugarcane as a substitute crop for jute. In addition, arrangements were made for the distribution of 19,072,000 cuttings of Co 213 cane to ryots. That the value of sugarcane as a revenue crop has been recognised by the cultivator would be apparent from the fact that the area under this crop increased from 276,000 acres to 325,000 acres, of which 244,000 acres are reported to be under Co 213. The unfavourable weather conditions in Western Bengal proved detrimental to paddy seed farms, which failed in a number of places. Still, about 25,000 maunds of Patna paddy No. 23 and 500 maunds of Balam paddies were distributed to ryots. There was an increasing

demand for departmental types of tobacco and 4,911 tolas of seed were distributed during the year.

In the UNITED PROVINCES, the departmental issue of seeds of all kinds reached a record figure of forty-two lakhs of maunds as against twenty-five lakhs of maunds of 1934-35. Of this, 39½ lakhs of maunds represented sugarcane. Wheat came next in importance, the total supply amounting to 185,000 maunds; 23,000 maunds of improved barleys and 12,000 maunds of improved paddies were also distributed. In this province the machinery for the supply of seed has been carefully reviewed and some modifications adopted. The method of free exchange of pedigree seed for the local produce, or issue of seed on loan for a period of years on the condition that the produce was effectively utilized for distribution, was found to be an improvement over all others, and the provision of funds under the All-India Rural Development Scheme paved the way to an expansion of this method. It is proposed in future to issue pure-stock seed for multiplication purpose and to have it grown in concentrated areas in villages adjacent to the departmental seed-stores under departmental supervision. The produce will be purchased for issue for similar bulk-sowings in selected development areas. The villages so supplied will be expected to build up their own stocks of seed from the original issues and not to require replacement for at least five years. An alternative method was also exploited in the Jhansi division of the Bundelkhand circle during the year. Here, with the active co-operation of the revenue staff, pure seed was issued at bazar rates to selected growers in each village who undertook to raise the produce for seed purposes, either by repurchase by the department or by issue to other cultivators in the province. In this way some 6,000 maunds of wheat seed was distributed in 1935 and provision has been made for the distribution of 2,000 maunds in 1936. This method is thought to be more suited to Bundelkhand conditions.

In the PUNJAB, as a result of the Seed Distribution Conference held in December 1934, statements have been prepared for each district showing the particular varieties most suitable for the different localities and these statements have been supplied to all officers

of the Revenue and other departments in the province for guidance. The total amount of seed of all kinds distributed to cultivators during the year was 223,100 maunds as against 167,510 maunds in 1934-35. The amount of wheat and cotton seed distributed was 145,000 maunds and 64,700 maunds. Seed-producing societies have been established in certain circles where there are no Government or private farms for the multiplication of seed.

In BURMA, the distribution of pure seed continued to be the most important service to the public, special attention being given to paddy as usual. For this crop there were twenty-four major seed farms comprising 2,823 acres and 171 minor seed farms comprising 10,344 acres. The total paddy seed distributed from all sources amounted to 15,468,717 lbs. as against 17,223,597 lbs. in 1934-35. The seed supply in regard to other crops amounted to 1,285,389 lbs. Sugarcane setts to the extent of 1,485,050 were also distributed. The decrease in paddy distribution is accounted for by the decision to withdraw an Emata strain from the list of pure strains.

In BIHAR AND ORISSA, the Department issued 32,430 maunds of sugarcane seed, against 10,700 maunds in 1934-35 ; 6,966 maunds of other improved seeds were supplied as compared with 4,105 maunds in the preceding year. The area under improved crops during the year is estimated at $5\frac{3}{4}$ lakhs of acres, while that under improved canes is not less than four lakhs acres representing about eighty per cent of area under cane in the province.

In the CENTRAL PROVINCES, the total number of private seed farms during 1935-36 was 23,428 as against 21,237 in the previous year. The total quantity of improved seed of all kinds distributed by the Department was 482,948 maunds as against 431,804 maunds in 1934-35. Over twenty million acres are reported to be sown with improved seeds, as against eighteen million acres in the last year.

Under the Verum Seed Distribution and Marketing Scheme, financed by the Indian Central Cotton Committee, the department distributed 3,248,504 lbs. of pure seed of long-staple varieties sufficient to cover an area of 103,537 acres. The quantity of staple cotton disposed of in 1935-36 amounted to 6,823 bales which fetched

an average premium of Rs. 42-9 over Broach and Rs. 60-4 over Oomra equivalent to a premium of 20·82 per cent on Broach and 32·26 per cent on Oomra, which compares very favourably with the figures obtained in all the previous years with the exception of 1934-35 when the corresponding premia were Rs. 62-3 and Rs. 82.

In ASSAM, the three departmental seed depots supplied 117,633 lbs. of paddy, 124,728 lbs. of seed potatoes and 303,761 sugarcane setts to ryots.

In SIND, the departmental organisation for the multiplication and distribution of seed of improved varieties of cotton and wheat was improved during the year by the establishment of ' Village Seed and Implement Depots ' at nineteen centres, so that the smallest cultivator could obtain the best seed at reasonable rates. The Government Auxiliary Farms are playing a most important part in the multiplication and distribution of improved varieties of cotton and wheat. The department handled 38,412 maunds of seed of improved cotton varieties, 6,071 maunds of rice seed, mostly of Kangni 27, Silver Jubilee, Jajai 77 and Bengal. Arrangements have been made to secure the co-operation of registered seed-growers to facilitate wider and more rapid extension.

In HYDERABAD, the department supplied seed of improved varieties of crops for an area of 56,938 acres during the year. A special staff was maintained for the distribution of Gaorani cotton seed in the Gaorani-protected area. Under the Indian Central Cotton Committee's Cotton-seed Extension Scheme, the department maintained a seed multiplication area of 7,000 acres and distributed pure seed to cover an area of 41,256 acres.

In MYSORE, 20,000 seers of *ragi* (*Eleusine coracana*), 39,000 seers of paddy, 15,000 seers of groundnut, and 16,225 setts of sugarcane were distributed through departmental and private agencies.

In BARODA over ten lakhs of lbs. of improved cotton seed (1027 A L F), covering an area of about 75,000 acres, were distributed in the Navsari district. In the Baroda district, as a result of propaganda, the seed of B 9 cotton departmentally supplied amounted to 14,480 lbs. to cover 1,448 acres. Under the Indian Central Cotton Committee's Scheme for the extension of 1027 A L F

in Baroda territory, distribution of pure seed was carried out on a large scale and there were clear indications that the area under Goghari had declined.

In TRAVANCORE, 18,589 lbs. of selected paddy seeds and 19,200 setts of improved sugarcane were distributed.

In COCHIN, the seed supply amounted to 11,000 *paras** as against 985 *paras* in the previous year.

6. Implements

In Appendix V will be found a statement of the agricultural implements sold through departmental agency. The total sales of complete implements in British India amounted to 79,957 as compared to 63,581 in the previous year and of spare parts to 53,244 as compared to 50,912 in the previous year. Plough sales numbered 28,655 compared to 20,414 in the previous year, large increases being shown by Madras, the United Provinces, the Punjab and Burma. Sales of ploughs are characterised in most provinces by one satisfactory feature, *viz.*, that the sales of spare parts exceed considerably the sales of ploughs—a useful indication that the ploughs are used. Sales of fodder-cutters in the Punjab rose from 26,070 to 28,768.

These figures are, however, no real measure of the extent to which improved implements have come into use. Manufacture and sale by private agencies is increasing and departmental sales in many cases represent only the immediate results of successful demonstrations. In all provinces the tendency is for the agricultural departments to devolve the supply of implements on other agencies as much as possible, and to concentrate on experiment and demonstration. Reference to the more recent work on the design of improved implements has been made in Chapter V. Demonstrations at agricultural shows, district exhibitions and fairs especially ploughing matches and similar competitions organised on these occasions are and are likely to remain important methods of propaganda.

In MADRAS the number of demonstrations with improved implements increased from 12,111 in the previous year to 12,987. The

* 1 *para* = 23 lbs.

department continued the free grant of 'takkavi' loans to enable ryots to purchase improved implements. The number of implements sold by the department was 3,806, of which 3,102 were iron ploughs.

In BOMBAY, the total number of implements sold through departmental agency increased from 3,372 to 4,036. The Taluka Development Associations continued to maintain implement depots for sale as well as for hire. The number of oil-engines and pumps is reported to be increasing rapidly and the iron mhote is tending to replace the leather mhote. Two large implement-manufacturing firms are located in the Bombay Presidency (one is in a State) and these firms now manufacture nearly every kind of agricultural implements and machinery including oil-engines.

In the UNITED PROVINCES, the sale of agricultural implements rose to 28,791, from 18,047 in 1934-35. The issues of whole ploughs and iron parts totalled over 10,000, this being largely due to the increasing popularity of the Meston and Gurjar ploughs and of hoes for inter-culture, the sale of which had trebled. 'Takkavi' loans continued to be granted to cultivators for the purchase of implements.

In the PUNJAB, improved implements like chaff-cutters, small iron ploughs, drills and bar-harrows were purchased in increasing numbers. In the Jullundur district alone there were a dozen small factories where chaff-cutters were made. In Ferozepore ploughs were made in large numbers by private agencies, and it is estimated that over 47,000 implements and spare parts were sold during the year through such agencies. About 29,000 fodder-cutters were purchased by zamindars, and Meston ploughs formed the bulk of the plough-sales.

In BURMA, the distribution of improved implements by departmental agency showed a considerable increase, the sales being—plough-shares 8,405, plough-bodies 389 and harrows 223 as against 4,769, 268 and 133 respectively in the previous year. A simple implement called the "Allan" *htoondo-gale* was designed as a cheap substitute for the imported inter-cultivator, and is reported to have become very popular.

In BIHAR AND ORISSA the number of implements and their parts issued increased to 2,435 from 2,022 in 1934-35. The 'Bihar' set of implements designed by Mr. Cliff and the Sukkada attachments for the country plough, designed by Mr. Sarkar, are being introduced into the countryside in large numbers. Both sets are cheap and light and are thus suited to the cultivators' pockets and bullocks. The manufacture of *rahat* pumps is now being done locally.

In the CENTRAL PROVINCES, a notable feature was the growing demand for ploughs, *rahat* water-lifts and wire fencing. The extension of fruit and cane cultivation in the Eastern circle has led to an improved demand for implements in that circle, the sales amounting to Rs. 16,727 as against Rs. 10,138 in 1934-35.

In HYDERABAD, the department supplied 1,156 implements during the year. Improved iron ploughs were popular in the Godavari and Karnatak Divisions and the 'Victory' plough in the sugarcane tracts.

In MYSORE, there was an improvement in the sale of ploughs and spare parts, the first rank among the sales being taken by the 'New Mysore Pattern' plough. There was an increasing number of local manufacturers of implements.

In COCHIN, the use of light iron-ploughs was making headway.

7. Fertilizers

Appendix VI gives the sales of fertilizers through departmental agency. Sales by private agency have always been important and were increasingly so during the year. Vigorous propaganda was carried on as usual by private firms in extending the use of chemical fertilizers and their application to cash-crops like sugarcane is increasing rapidly. At the same time the agricultural departments have increased their efforts to popularise the preparation of composts from organic waste, better methods of preparation of farmyard manure and the use of green manures wherever possible. Imports of fertilizers including ammonium sulphate amounted to 72,210 tons in 1935-36, compared to 13,827 tons (revised figure) in 1934-35. Indian production of sulphate of ammonia amounted to 17,851

tons in 1935-36 and the approximate consumption of ammonium sulphate to 57,164 tons in 1935-36, as compared to 51,649 tons (revised figures) in 1934-35.

In MADRAS, the number of improved manure-pits maintained at the instance of the department rose from 13,166 to 28,586 and the number of compost-pits from 1,250 to 1,683. The conversion of night-soil into poudrette by the modified Indore process was widely demonstrated and a number of municipalities are reported to have interested themselves in the matter. The introduction of green manure crops, like *dhaincha*, sann-hemp, *pillipesara*, wild and ordinary indigo, was encouraged wherever possible and 180 tons of green manure seed was distributed through private agency in two circles. The use of artificial manures in combination with bulky organic manures continued to be advocated and good sales are reported. The practice of green manuring paddy and sugarcane is steadily increasing, about 167,233 acres being the estimated area under this improvement during the year; and 41,352 acres of paddy and 13,430 acres of sugarcane were manured with concentrated manures in four circles.

In BOMBAY, the preparation of organic manures like farmyard manure, poudrette and compost received increased attention and the Taluka Development Associations co-operated in the matter. Standardised and simplified dry and wet methods of preparing compost were described in a leaflet published in all the languages of the presidency. Increasing use was made of green manures for wheat in Khandesh. The application of bone-meal to fruit orchards is also becoming popular. Firms dealing in oil-cakes and fertilizers have now got their agents at a number of places. The total amount of manures distributed by the department was 26,139 cwts. of commercial fertilizers and 7,026 cwts. of oil-cakes.

In BENGAL, artificial farmyard manure was manufactured as a matter of routine on all Government farms, the total quantity manufactured being 32,470 mds. The sales of artificial fertilizers, mainly ammonium sulphate, amounted to 1,351 tons.

In the UNITED PROVINCES, the total amount of fertilizers distributed by the Department was 191,909 mds. against 89,541 mds.

last year. To encourage the use of concentrated fertilizers for cane, the department issued in the tube-well and other development zones mixtures of ammonium sulphate and oil-cakes. The quantity of the mixture issued was over 63,000 mds. and provision for the issue of nearly double this amount was made for the 1936-37 season. The preparation of compost was continued on all departmental farms.

In BURMA, sales of fertilizers amounted to 610 tons; of this amount 345 tons represented artificials and the remainder bone-meal. The use of artificials on paddy nurseries is reported to be on the increase but the greatest scope for the use of fertilizers was on the sugarcane crop. In the case of paddy the margin of profit was too small to lead to any considerable expansion at present prices.

In BIHAR AND ORISSA, the sale of fertilizers by the department rose to 27,262 mds. from 15,000 mds. in the previous year. As a result of the department's demonstrations, the firms dealing in artificial fertilizers sold in South Bihar alone some 35,000 mds. of chemical fertilizers valued at Rs. 1,32,702.

In the CENTRAL PROVINCES, the demand for artificial manures for cane cultivation increased and the distribution in the Southern circle amounted to 5,438 mds. as against 2,542 mds. in the previous year. The rapid extension of fruit and cane cultivation in the Eastern circle has led to an increased sale of chemical fertilizers and oil-cakes in that circle, which amounted to 5,927 mds. as against 1,320 mds. in the previous year.

In HYDERABAD, the department supplied manures for an area of 8,992 acres during the year. The Imperial Chemical Industries, Ltd., have opened agencies in many parts of the State In MYSORE artificial manures were increasingly used in the Irwin Canal area.

CHAPTER X

AGRICULTURAL EDUCATION

1. Agricultural colleges

DURING the year there was an increased demand for admission into the agricultural colleges at Coimbatore, Poona, Cawnpore, Lyallpur and Nagpur. This was partly due to the improved prospects of employment for trained men in Government and other services during the year and partly to the general revival of enthusiasm for agricultural work throughout the country. With the spread of the rural uplift movement and the general awakening of interest in the subject of agriculture and its improvement, a larger number of young men are now being attracted to an agricultural career.

MADRAS. There was an improvement in the number of applications for admission to the Coimbatore Agricultural College which rose from ninety-one in the previous year to 116 in the year under review. The number of fresh admissions was forty-four. Twenty-six students appeared for the final B.Sc. (Ag.) examination and twenty-three passed. As usual, the research officers of the department assisted the college by giving a number of special lectures in their subjects and fifteen such lectures were given during the year.

BOMBAY. The Poona Agricultural College continued to be popular in spite of a recent increase in the college fees. There was keen competition for admission to the college, the total number of applications for admission being 130, of which twenty were from outside the province. The number of actual admissions during the year was eighty-eight, of which seventy-three were from the province and five from outside. The total number on the rolls at the end of the year was 161. Sixty-one students sat for the final B. Ag. degree examination, under the old regulations, and forty-three passed. The candidates undergoing the course for the B. Sc. (Ag.) degree under the revised regulations completed their final session during the year. The introduction of the revised courses of study has necessitated extensive additions to the laboratory and other

equipment, and a five-year plan of extensions was approved by Government. Three post-graduate students enrolled for the M. Sc. degree and one for the M. Ag. degree. The Agricultural Graduates' Employment Bureau functioned successfully, and eighty-five graduates registered themselves at the Bureau. It is of interest to note that the sugar factories alone absorbed no less than thirty graduates during the year.

BENGAL. The scheme for the establishment of an Agricultural Institute at Dacca has not yet materialised owing to lack of funds. It is, however, gratifying that the nucleus of a higher Agricultural Institute was established at Rajshahi with the legacy of the late Kumar Basanta Kumar Roy of Dighapatia. The course of study at this institution will include theoretical and practical training in agriculture, horticulture, dairy-farming, poultry-farming and cigar-making, covering a period of four or two years, according as the students are matriculates or intermediates. The scheme is expected to come into operation shortly.

UNITED PROVINCES. The changes carried out in the organization of the Cawnpore Agricultural College in 1932 are reported to have resulted in increased efficiency. The number of applications for admission was 129, an increase of thirty-two over the previous year. Of these, fifty-four were admitted. The total strength of the college at the end of the year was 160. Forty-seven candidates appeared for the revised B. Sc. (Ag.) degree examination and forty-two were successful. Of the 164 graduates turned out by the college during the period 1931-35, only fifteen are reported to be unemployed.

The Allahabad Agricultural Institute continued to train students for the B. Sc. (Ag.) degree of the Allahabad University. Of the twenty-nine students who applied for admission, twenty-one were admitted, the total number of students on the rolls being thirty-seven. Six candidates graduated during the year.

PUNJAB. There were 180 applications for admission to the Punjab Agricultural College, Lyallpur, as compared to 137 in the previous year. The number of actual admissions was sixty-eight. Twenty-nine candidates appeared for the final degree examination

and fifteen were declared successful. There was only one admission to the post-graduate course leading to the M. Sc. degree. The question of making the M. Sc. course more popular is engaging the attention of the department. An alteration has been made in the college terms to make them correspond with those in other colleges and this has been advantageous. An Employment Bureau has been established to meet the demand from the zamindars of the province for trained estate managers.

BURMA. The Agricultural College, Mandalay, continued to remain closed to students as a measure of retrenchment.

CENTRAL PROVINCES. The Nagpur Agricultural College received eighty-nine applications for admission, of whom forty-eight were admitted. The number on the rolls of the first year class at the end of the year was forty-six and of these thirty-three were promoted to the second year class. Twenty-four students sat for the degree examination and twenty-two passed. A College Council was constituted during the year in conformity with the system in other Government colleges. Post-graduate training in agricultural chemistry was provided for two students.

The Hebbal Agricultural School, MYSORE, received fifty-four applications for admission to the 4-year Diploma course and admitted thirty-seven. The total number of students in residence at the school was ninety-two. Thirty-seven students sat for the final examination for the Diploma and thirty-one were successful.

2. Post-graduate training in agriculture

The IMPERIAL AGRICULTURAL RESEARCH INSTITUTE received thirty-three applications for admission to the post-graduate courses beginning in November 1935, of whom eighteen were recommended by provincial authorities concerned with the nomination of students. Thirteen applicants were selected for admission, four in botany, four in agricultural chemistry, one in entomology, one in mycology and three in general agriculture. During the year seven post-graduates completed the two-year course, four in botany, two in agricultural chemistry and one in entomology. The one-year course in farm organization, farm management and general farm

engineering was completed by three students. Two candidates obtained their M.Sc. degrees on theses prepared under the guidance of officers of the Institute.

The newly constructed Institute at New Delhi is designed and equipped to meet all possible requirements of post-graduate students and the Institute has been recognised by several Universities in India as a place where work can be done towards higher degrees. The question of according some form of recognition to the regular post-graduate courses of the Institute has been considered and Government of India have recently issued orders that those who have in the past satisfactorily completed the course in any of the subjects, or who may do so in future, would be regarded as Associates of the Imperial Agricultural Research Institute and that they will be entitled to affix to their names the abbreviation, Association I. A. R. I. Facilities for post-graduate work in agricultural sciences continued to be available at the Agricultural Colleges at Coimbatore, Poona, Cawnpore, Lyallpur, Nagpur and also at the Benares Hindu University, where post-graduate courses have been instituted in agricultural botany. A two-year course of post-graduate training in agricultural chemistry was started at the Agricultural Research Institute, Sabour, during the year.

3. Agricultural schools

School education in agriculture continued to be popular in many provinces.

MADRAS. The Agricultural School at Usilampatti continued to be under the management of the District Board, Madura, and had thirty students during the year. An Industrial School giving a two-year course in agriculture and subsidiary industries was started at Muthanadal by the Ramnad District Board, and twenty-seven students were admitted. The three Farm Labourers Schools at Anakapalle, Palur and Coimbatore continued to function and a total of 103 students underwent training at these schools.

BOMBAY. The two agricultural schools at Devihosur and Dhulia continued to train students, the number on the rolls in each of these being thirty-two. In addition to these two schools, there was an

aided private agricultural school at Rajapur in Ratnagiri district which, besides training boys in agriculture and allied subjects, has taken up the training of primary school teachers for 'bias' classes. Classes were organized by the Agricultural Department in collaboration with other departments for rural reconstruction workers. The American Presbyterian Mission authorities at Sangli again arranged a most successful course for rural workers.

BENGAL. There has been an increased demand for admission into the Secondary Agricultural School at Dacca, due mainly to the provision of stipends by the District Boards for students coming from their respective districts, fourteen stipends having been allotted during the year. Of the 429 applications received for admission, only twenty could be admitted, but accommodation for a larger number would be available in the following year on account of the suspension of the scheme for the training of 'bias' school teachers at this institution. A proposal of some of the District Boards to train demonstrators at this school is under consideration.

UNITED PROVINCES. The Agricultural Schools at Bulandshahr and Gorakhpur functioned satisfactorily during the year. The Bulandshahr School received sixty applications for admission and admitted thirty-five. The total strength of the institution during the year was sixty-seven, of whom fifty-three were in the Diploma classes, and the rest in the Fieldmen and Farm Mechanic classes. The school turned out during the year twenty-five Diplomates, six fieldmen and eight farm mechanics. In addition to these, two batches of Rural Development organizers numbering 112 in all were trained at the school. The Agricultural School at Gorakhpur received 115 applications for admission as against sixty-four in the previous year; the number admitted during the year was forty-two. The total strength of the school during the year was fifty-six, of which forty-four were in the Diploma classes and the rest in the Fieldmen class. Seventeen Diplomates and twelve fieldmen passed out of the school during the year.

PUNJAB. The Certificate course in agriculture at the Lyallpur Agricultural College was taken by nine students, of whom eight were successful at the examination. The demand for the summer

and winter vernacular classes is reported to be on the increase and thirty-nine and twenty-seven students were admitted to these, thirty-five and twenty-five being successful at the final examination. A one-year course for *malis* was started during the year and fifteen were admitted.

BURMA. The Pyinmana Agricultural School, maintained by the American Baptist Mission, admitted thirty-four students during the year, the total strength at the end of the year being seventy-two. Twelve students were successful at the final examination. In addition to the present ordinary four-year course, which is of a combined literary and agricultural character, provision has been made for a shorter course in agricultural subjects only.

CENTRAL PROVINCES. The Robertson Anglo-Vernacular Middle School, Powarkheda, started the year with eighty-five students on the rolls, but in the course of the year suffered a fall in numbers, particularly in the sixth and eighth classes, which reduced the strength to sixty-eight. All the boys of the school were sons of *malguzars* and cultivators in equal proportions. Ten boys were sent up for the High School Entrance examination and nine passed. It is hoped that the fall in the attendance of the school is only temporary and may be attributable to depressed conditions. The Peace Memorial Agricultural School at Buldana received fifty applications for admission but admitted only sixteen. Ten boys appeared for the final examination and seven were successful. Arrangements were made during the year for the Department of Agriculture to take over from the District Council the Betul Bazar Agricultural Anglo-Vernacular Middle School.

MYSORE. The Vernacular Schools at Chikkanahally, Ramakrishnapur and Hassan in Mysore continued to be popular. There was keen competition for admission to these schools with the result that they maintained their full strength which was eighteen, nineteen and fifteen, respectively.

BARODA. At the Agricultural School on the Baroda Farm the number of students trained was twenty-three. Twenty-five students were admitted to the new session which commenced in

June 1936. An Agricultural Institute to be called the Sheth Dosabhai Agricultural Institute is under construction on the Baroda Farm and the present agricultural school will form part of the Institute. It is intended that the institute course will extend over a year and will be devoted to general agriculture and horticulture. In the second year there will be, in addition, several specialised short courses in the running of oil-engines, fruit preservation, dairying and other subsidiary industries.

TRAVANCORE. The Agricultural Middle Schools at Kottarakara and Koni continued to function. The course of studies extends over two years and the sessions commence at each school in alternate years. At the Kottarakara school sixteen students sat for the final exmination and thirteen passed. In addition, seven students who had failed in the previous final examination held at Koni appeared for this examination and six were successful. Twenty new students were admitted to the school during the year. The Koni school had twenty-four students on its rolls during the year.

4. Rural ' bias ' schools

The system of introducing agricultural classes in middle schools is increasing in popularity and is being slowly extended.

In MADRAS, three Board High Schools have introduced agriculture as an optional subject in the S. S. L. C. curriculum. In BOMBAY, there were ninty-three ' bias ' classes during the year, of which eighty-two were under Board management, six were run by Missions and five by Indian States. Most of them are reported to have done good work. As usual the classes were inspected by the Inspector of Agricultural Schools belonging to the Agricultural Department. Two high schools in the province have introduced agricultural courses in the school curriculum. In BENGAL, fifty-one high and middle schools conducted agricultural classes as against forty-one in the previous year. Twenty-five per cent of these schools have been classed as ' good ', fifty per cent ' fair ' and twenty-five per cent ' indifferent'. As many as 3,043 students received instruction in agriculture in these schools during

the year. The schools were regularly inspected and steps were taken to eliminate those which did not show progress. The subject of the teaching of nature study in primary schools met with encouraging results during the year, and the number of primary schools with provision for such training increased in many of the districts.

The Aligarh Muslim University has included agriculture as an optional subject in the University courses and in the high schools affiliated to it. In many high schools in the UNITED PROVINCES, agriculture has been included as an optional subject, while a number of vernacular middle schools have incorporated agriculture or rural knowledge in their curriculum. The members of the Agricultural Department visit such schools and give talks and lectures to students. In the PUNJAB, the ten-month teachers' training class for the ' bias ' schools was taken by thirty teachers. In ASSAM, the introduction of gardening in schools made satisfactory progress and 250 schools maintained gardens during the year.

In TRAVANCORE, agriculture has been included as one of the optional subjects for the Vernacular School Leaving Certificate examination and the number of pupils who took the final examination in this subject during the year exceeded 5,000. A few agricultural ' bais ' schools have been started in this State through private enterprise.

5. Short courses

Short courses on special subjects or general agriculture continued to be given by all agricultural departments in India. These courses, which may be only a matter of a few days or may last some months, are increasing both in popularity and utility.

At PUSA, a two months' course in the flue-curing of tobacco was attended by four candidates.

In MADRAS, a class in farm management of nine months' duration and shorter courses in malt-making, jaggery-making and bee-keeping were held at Coimbatore and a total of ninety-seven students underwent the courses. Similar classes have now been started at

Nandyal in Kurnool district and Taliparamba in Malabar district. In BOMBAY six courses were given in horticulture and five in agriculture, four in agri-horticulture, one in poultry-farming and two in sugarcane agriculture. A class in the driving of oil-engines and pumping plants was taken by ten students.

In BENGAL, a scheme for the training of *bhadralok* youths in Faridpur was launched at the instance of the Collector of Faridpur and has made some progress. Twenty-nine boys have been trained of whom twenty-three have been allotted land and a number of these are reported to have shown initiative and enterprise.

In the UNITED PROVINCES, a class in improved agriculture was held for forty co-operative supervisors at Partabgarh. Forty-eight men were also trained at this centre for the Rural Development Schemes. The training of organisers for rural development work was also undertaken at the Benares Farm. The Moss Agricultural Institute at Ghazipur continued its useful activities and nineteen candidates received training. A member of the Subordinate Agricultural Service was attached to the institute.

In the PUNJAB, short courses in fruit culture and preservation of fruit and vegetables were taken by seventy-two students. A course in subsidiary industries was attended by twenty-one Agricultural Assistants and the vernacular course in dairying by eleven candidates. Short courses were also given in sugar chemistry and in the control of diseases and pests.

BURMA. The Farm Schools at Hmawbi and Mahlaing continued to give a nine months' practical course in agriculture. Twenty students passed out of these schools during the year. In addition to these Farm Schools, shorter demonstration courses in agriculture were arranged for thirty-three students.

In BIHAR AND ORISSA, the central farms continued to train their own overseers and *kamdars*.

In ASSAM two agricultural training classes were held, one at Sylhet and the other at Jorhat, each class consisting of ten stipendiaries. The classes proved popular and the question of starting colonies for the trained boys is under consideration.

In HYDERABAD, short courses were given in the running of oil-engines and in gardening. Classes in general agriculture were also organised for sons of farmers on the State Farms.

In BARODA, five courses, each of three weeks' duration, were given at Kosambi, in kitchen gardening, fruit culture, poultry farming, etc.

In COCHIN, an agricultural school was run on the Central Farm for selected teachers of primary schools and others, and sixteen students took advantage of the course.

CHAPTER XI

THE CO-OPERATIVE MOVEMENT AS AFFECTING AGRICULTURE*

THE year 1935-36, the seventh year of the slump in agricultural prices, saw little relaxation of the tension and strain on the co-operative movement to which reference was made last year. From almost every quarter comes the same litany of complaints of frozen debts and vanished repaying capacity. The shadow of overdues overhung almost all co-operative effort and naturally energy tended to be concentrated on what were termed schemes of "relief", "re-organisation" or "rectification". These schemes meant in essence the same process, namely, on the one hand, coercive action against wilful defaulters and on the other lightening the members' burden by reducing lending rates, re-fixing instalments, postponing demands of shares, adjusting shares against dues, scaling down or remitting demands out of the society's funds formed from past savings and inquiring in each case into assets, repaying capacity and security. From the very nature of the agriculturist's economic position, there could have been no dramatic recovery as measured in terms of percentages of arrears and figures of advances and collections, yet as the results of these measures come to be recorded, one sees indications of a definite adjustment to the altered circumstances. Individual borrowing limits have been reduced, the distinction between short-term, intermediate-term and long-term credit is being recognised in practice and finance is better related to the particular need, unproductive expenditure has been curtailed under the stress of necessity, payment, however small and halting, has begun in many areas, where the first shock of the slump had petrified the business of societies, more societies felt justified in giving credit again to their members, though naturally on a scale restricted by the reduced repaying capacity. The pace of liquidation has slowed down, while the policy of "cautious expansion" advocated by the

* The assistance of Mr. Vishnu Sahay, I.C.S., Registrar of Co-operative Societies, United Provinces, in the preparation of this Chapter is gratefully acknowledged.

Registrars' Conference of 1934 is being pursued in many provinces. Where the co-operative quality of the society was good, there has been a welcome response to the measures of relief, and overdues are perceptibly lighter, though, of course, in precarious tracts, where crops have been bad, or in tracts like Berar, where the average borrowing is excessive, the response has been much less obvious. The general credit of banks was high and some of them attracted deposits as cheaply as the large commercial banks. Broadly speaking, the movement may be said to have stood its ground during the year, though there was no marked advance as a whole.

Apart from compelling internal stock-taking and adjustments, another general result of the slump has been the recognition of the necessity of outside control, though not necessarily State control, of co-operative societies during their period of growth. The Co-operative Societies Act of 1912 stressed their autonomous character, but the deterioration that set in after 1930 exposed the danger of premature independence and recent legislative tendency has been in the direction of giving extensive powers of intervention to the Registrar at a stage when the use of such powers can be effective; till now the Registrar had the extreme power of liquidation but lacked moderate powers. Bihar, Madras, Bombay and Burma now possess separate acts of their own, and a draft bill was on the *tapis* in the Punjab also. In Madras the power of supersession was used in over 1,400 societies, and the results are reported to be satisfactory. In the United Provinces and the Punjab, a considerable measure of control over village societies was in practice exercised through a mixed staff of Government servants and supervisors of Union of Banks.

In a period of low prices, co-operative credit standing by itself was bound to get into difficulties, and a feature of the year was the development of non-credit activities and in particular of marketing and those measures which go under the name 'better-living.' While there has been no appreciable progress in the marketing of cereals, which have a dispersed and distant market, there has been noticeable progress in purchase-and-sale societies for produce like sugarcane, ghee, cotton, fruit and milk. Processing was rarely

attempted, the usual function of the societies being collection of the produce and its joint sale to the public, the traders or to private factories. The United Provinces, the Punjab, Bihar, Bombay and Madras all have cane-growers' societies, the largest development having been in the first named province where nearly seventy-five lakhs maunds of cane passed through the societies. Madras registered a Provincial Marketing Society, which has begun with fruit. Paddy in Burma and grain in the United Provinces were marketed by financing institutions on behalf of members in order to stimulate repayment and the results point to the effectiveness of combining credit with marketing. Apart from marketing, a welcome feature of new registrations is the increasing attention paid to such aspects of co-operative activity as consolidation of holdings, cattle-breeding, irrigation and land reclamation. Better-Living Societies, with wide objects ranging from better sanitation to social reform, received a fillip from the Government of India grants for rural reconstruction and the idea of a comprehensive campaign of rural welfare through associations of villagers steadily gained ground. In addition to separately organised Better-Living and Better-Farming Societies, a large number of credit societies also widened their scope of work, and as an annexe to their credit business, adopted various items of a 'better-living' programme.

The slump accentuated the notoriously oppressive indebtedness of the small-holder, and among schemes of control of usury and debt-relief and conciliation, increasing attention was focussed on land-mortgage banking. In Madras, which has progressed the most in this direction, the Central Co-operative Land Mortgage Bank has doubled its business in two years, and further expansion is envisaged with an increase in Government supervising staff and in the amount of debentures guaranteed by Government. A central land-mortgage bank for the province was organised in Bombay, and the subject has received earnest consideration in Bihar. The small banks in the United Provinces showed some promise, while several of the Punjab banks showed better recoveries.

The Royal Commission on Agriculture pointed to the deficiency of co-operative training and education as one of the basic weaknesses

of the movement; the deficiency had been recognised, but lean times and shortage of funds prevented any large-scale attack on the problem. A feature of the year under review was the adoption in all provinces, thanks to the Government of India grant referred to last year, of comprehensive schemes for the training of staff and for the training and education in co-operative principles and practice of members and secretaries of village societies.

During the year the Government of India ordered certain changes to be carried out in the statements appended to the Annual Reports on the working of Co-operative Societies in the provinces, which would facilitate a better appreciation of the strength and the soundness of the various co-operative societies.

Some detailed figures are furnished below regarding the movement in the different provinces and States.

PUNJAB. After the check imposed by the depression, expansion in the number of societies, membership and business has begun again. Four-hundred-and-forty-three new credit societies were registered. On this expansion, the Registrar makes the following remarks, which are applicable to the rest of India also:—"Two aspects in this expansion give rise to some anxiety; one is that there is no guarantee of permanence in the staff which has been provided for the organisation of new societies and the second is that these new societies are inclined to lend more freely than modern enlightened opinion would allow for such objects as expenditure on weddings". Overdues continued to be a problem; the percentage of principal recovered on the total amount of loan at the beginning of the year was 13·5 as compared with fifteen last year, while the total overdue interest stood at the formidable figure of a crore and a half rupees. The reserves are, however, considerable. The bulk of the province registered a slight recovery, but the provincial averages have been dragged down by the south-eastern districts where there has been considerable deterioration. Part of the money is irrecoverable, but adjustment of debt is made difficult by the psychological danger of the debtor taking encouragement for further default in the hope of more remission; the policy is to concentrate on increasing reserves. Lending rates

have also been reduced, while in many districts, a feature of the year was a search for subsidiary sources of income, such as sheep-breeding, wool-spinning and ghee.

The Punjab had from the first a well-trained departmental staff, which was utilised on training non-official co-operators. With the help of the Government of India grant, the number of secretaries' classes increased from eighty to 154 and the number of secretaries who attended rose from 1,097 to 2,340. There were also sixty-six classes for 2,750 office-bearers.

The improvement in some of the land-mortgage banks, which was noticeable last year, continued. Recoveries increased from Rs. 1·46 lakhs to Rs. 1·76 lakhs. Overdues also decreased. Speaking of the banks which are in difficulties, the Registrar remarks, "they are not receiving the help they should from honorary workers; having discharged the agreeable duty of giving loans to themselves and to their friends, they leave to the departmental staff the unpleasant and difficult task of recovering them. In fact, practically all recoveries made in such banks are due to the efforts of the departmental staff". Schemes of reorganisation involved among other things alteration of the revenue law; no alteration of the Land Alienation Act is, however, contemplated.

There was considerable expansion in that most important speciality of this province, *viz.* societies for consolidation of holdings. The Punjab Government maintained a staff of eight Inspectors and 104 Sub-Inspectors for this purpose, to these were added seven Inspectors and eighty-three Sub-Inspectors maintained out of the Government of India grant for rural reconstruction, and seven Assistant Inspectors and twenty-six Sub-Inspectors paid for by the villages under consolidation. One-hundred-and-fifty-seven new societies were registered, the area consolidated increased from 66,000 acres to 93,000 acres, and the cost of consolidation decreased from Rs. 1-11-8 to Rs. 1-6-11 per acre. The work is steadily getting popular and contributions are given more willingly, the total contributions being Rs. 45,000.

Better-Living Societies increased from 590 to 736 with the assistance of a special staff of four Inspectors and sixteen Sub-Inspectors. Their scope is expanding and embraces nearly every aspect of rural reconstruction.

BOMBAY. The policy of weeding out improvident members from societies and cancelling bad societies continued, while to meet insistent demand, about 120 new societies were registered after strict scrutiny and under limitations about their loan operations. The working capital and reserve funds have increased; the number of members however fell, partly owing to the elimination of undesirables and mainly owing to the reduced membership of the Taluka Development Associations. The number of agricultural societies of all kinds was 3,811 with 2,62,000 members and a working capital of Rs. 3,21,00,000. Of these 3,614 were credit societies with about two lakh members, and Rs. 2·91 lakhs as working capital. The fresh finance during the year was Rupees sixty-nine lakhs as compared with Rupees seventy-eight lakhs last year. The recoveries were less than last year, and here also overdues are heavy, which, the Registrar remarks, can only be collected in instalments.

A landmark in the development of the credit movement in the province was the establishment, in December 1935, of the Bombay Provincial Co-operative Land Mortgage Bank with an authorised capital of Rupees ten lakhs, of which Rs. 3,63,000 have already been contributed. During the short period of its existence, the Bank dealt with applications for loans for nearly Rupees three lakhs; the actual amount advanced to primary banks was Rs. 68,000. There was no addition to the ten already existing primary land-mortgage banks. An unsatisfactory feature, here as elsewhere, was that almost all the loans were for redemption of prior debts and not for some productive purpose like improvement of the land. One good result, however, was the voluntary moderation of the demand. In the words of the Registrar, the banks "supplied a machinery for securing conciliation of debts without detriment to the legitimate interests of either the creditor or the debtor" and during the year conciliation to the extent of Rs. 41,000 was secured from creditors.

An important achievement of Bombay is their twenty-seven Cotton Sale Societies, mostly situated in Gujarat and Khandesh. These made steady progress and helped in improving the quality of cotton and in securing better prices. Nearly 3,65,000 maunds of cotton worth Rs. 33,00,000 was sold through these societies. There was development in co-operative processing also. The Farmers' Co-operative Pressing Factory at Surat saved its members substantial amounts in both ginning and pressing operations; the turn-over of the Purushottam Co-operative Ginning Society increased considerably and two more ginning societies were started during the year.

Crop-protection Societies and Fencing Societies, which both have similar aims, had another year of useful work; the former protected an area of about 53,000 acres at a cost of less than five annas an acre; the latter put 68,000 yards of wire-fencing to protect 20,000 acres at a total cost of Rs. 77,000. The good work done by the societies was recognised in the new Chapter XI added to the Co-operative Societies Act, which will enable coercion of recusant minorities and will thus facilitate the operations of such societies.

Taluqa Development Associations increased from seventy-one to ninety-five and many of them did useful work by way of improving strains of paddy, distribution of fertilisers and vegetable seeds and propaganda regarding fruit cultivation. According to the Registrar, these associations not merely served as a frame work for agricultural propaganda but also supplied an excellent machinery for rural uplift.

MADRAS. A vigorous policy of reformation was pursued. Inquiry was made into the affairs of the societies, bad debts were estimated, security was taken for inadequately secured loans, the special staff engaged on "rectification" attended to collection also, extensions were given where necessary, penal interest was waived, rates of interest were lowered, attempts were made, wherever desirable, to revive societies by supersession of the committee or by the less formal remedy of appointing agents and finally when revival was impossible, cancellation was ordered. Three-hundred and thirty-four societies were thus cancelled, while the committees

of thirty-five were under supersession and agents were appointed in 992 societies. The total number of agricultural societies was 11,515 of which 10,989 were credit societies. Lendings to members increased from Rs. 125 lakhs to Rs. 149 lakhs, a sign of returning normality. An encouraging result of the year was the reduction in the percentages of overdues against members of societies in principal, arrear-interest and current interest from 68, 72 and 59 to 65, 71 and 48. There was similar improvement in the repayments by societies to banks. The detailed inquiries show that there are ample reserves with banks to meet estimated bad debts.

The Central Land Mortgage Bank completed one more year of progress. In the last two years its business has more than doubled, there are no overdues and the bank worked at a profit even after allocating a substantial sum to a bad debt's reserve and after paying for the Government staff employed on the bank. Advantage was taken of easy money and old high interest-bearing debentures were converted, most of the renewals being to the old debenture-holders. The lending rate to primary banks is one per cent above the borrowing rate on debentures, which does not exceed four per cent, and the ultimate lending rate to the agriculturist is now not more than six per cent anywhere. The debentures are quoted in the market at a premium, their principal and interest are guaranteed by Government, and during the year Government agreed to guarantee debentures up to one crore of rupees.

The number of primary land mortgage banks rose from seventy-six to eighty ; their membership and working capital have increased threefold since 1932-33 ; arrears in principal and interest have been reduced substantially and are largely confined to the banks started before the slump. Borrowing was nearly all for payment of prior debts, and here also some voluntary conciliation was achieved. There is keen demand for more land mortgage banks and the organisation is steadily developing in efficiency.

A characteristic of the year was the attention paid to marketing. There was a conference of official and non-official co-operators to discuss the development of non-credit activities and a Provincial Marketing Society was organised to co-ordinate the transactions

of the various loan-and-sale societies and also of stores by connecting them with centres of production and marketing. Government have helped with staff and an annual subsidy of Rs. 2,800 for three years. The number of purchase-and-sale societies rose to ninety-three, of which seventy-four were loan-and-sale societies. These societies acquire godowns in which the member can store his produce, while he gets an advance on it and he can thus sell at his convenience. There is no joint sale, but these societies serve as a half-way house to the development of co-operative marketing. Their chief problem is godowns and Government offered help with grants of one-fourth of the cost and cheap loans for the rest. Seventeen societies have applied for a sum of nearly Rupees three lakhs under this scheme.

A recent activity in the field of co-operation was in the organisation of twenty-one Better-Living Societies, which have begun with a broad programme of moral and economic improvement, including retrenchment on ceremonial expenditure, temperance, night schools, arbitration, sanitation and thrift.

The Registrar remarks in his last report " The economic depression still continues and the general prosperity of the ryot has not substantially improved, though there are signs of a rise in the prices of paddy and other commodities..... During the past year increasing importance has been given to non-credit work. There has been a big increase in the number of non-credit societies and a beginning in dealing with co-operative marketing. With some increase in staff, the department should be able to cope with these important activities ".

UNITED PROVINCES. The credit movement appears to be emerging from the crisis of the slump without serious mishap. A policy of nursing continued, coupled with " cautious expansion " of credit societies and a marked development in marketing and ' Better-Living ' activities. The number of credit societies increased slightly to 6,000, with 125,000 members and a little over a crore of working capital. Various schemes of relief and adjustment as outlined in the first paragraph of this review were adopted and resulted in stimulating recovery. Both advances and collections increased ; the percentage of recoveries on demand *plus* overdues of the previous

year was forty-five, it was thirty-six last year and thirty the year before. Overdues decreased by Rupees six lakhs to Rupees thirty-eight lakhs. The average membership also rose. These are significant figures and show that the credit movement, as a whole, seems to have turned the corner, though, as the Registrar points out, progress is very uneven, the bad societies stagnated, while the good societies show disproportionately marked improvement.

Several schemes are being tried to further thrift; in some places there are thrift policies under which a member paying Rupees two a year would get Rupees fifty at the end of fifteen years. In some, compulsory deposits are taken in advance, a departure from orthodoxy which has been permitted under the necessity of enforcing thrift, and in some a portion of the interest recovered was credited to the member's deposit account. Exhortation and precept alone do not appear to have brought about the saving habit and the general tendency has been in the direction of compulsive measures based on group agreement.

The number of Land Mortgage Societies remained unchanged at five. The working capital rose from Rs. 60,000 to Rs. 98,000 of which 23·4 per cent is owned. The total advances were about the same as last year, *viz.*, Rs. 43,000 and there were no arrears. Lending rates are high and the periods of instalments low. The Registrar remarks " As experiments on which to base future policy, these results are encouraging, but the plain fact of the matter is that unless two essentials of land-mortgage banking—long instalments and a low rate of interest, so that the demand is within the repaying capacity—can be ensured, the number of land-owners that can be safely helped will be very small."

The most important development in the sphere of non-credit co-operation was in cane-supply societies. Their business expanded, nearly three quarters of a crore maunds of cane was sold through them and in some districts, the amorphous organisation with which they had to begin showed signs of turning into a live closely-knit organism with pronounced loyalty. The pivot on which they hung was privately-owned factories and with the increase in the production of cane, there were indications of serious difficulty in the future

in obtaining contracts from them. A state-aided scheme of improvement of cane and its joint sale was adopted in the home areas of twenty factories; the improvement in cane is already visible, while the marketing part of the scheme will come into full operation next year when the whole area has been developed.

The other considerable development was in Ghee Production and Sale Societies. The Chaubon-ka-purwa Ghee Sale Union, with forty-four primary societies and 1,114 members sold about 1,100 maunds of ghee, earned profits and introduced improved cattle and cattle-feeds. The ghee has a reputation for quality and fetches a premium in the neighbouring market. The number of such societies in other districts of West United Provinces is rapidly increasing.

Other features were eighty-two societies for consolidation of holdings, thirty-six irrigation societies, and a scheme in Moradabad and Kotdwara for enabling members of village societies to sell their produce through accredited agents of the financing bank at slightly higher than market prices. A noticeable result of this scheme, which is also shared by the co-operative credit societies which collaborated with cane-supply societies in arranging for the sale of the member's sugarcane, was an enormous improvement in repayment.

Better-Farming and Better-Living Societies increased and in addition, a large number of credit societies were taught to act in association for general purposes like better sanitation, prevention of litigation, limitation of extravagant expenditure, village games and the like.

BIHAR AND ORISSA. The policy as regards expansion is stated thus in the last departmental report " The pace of progress which was too rapid up to 1925-26 was slowed down since 1926, when owing to the deterioration in the quality of societies, a brake was applied and expansion came to be restricted in pursuance of a policy of greater attention to consolidation and the improvement of existing societies than to mere quantitative progress and the policy initiated in 1926 has been maintained ever since . . . . . Attention was chiefly directed to the organisation of special types of societies such as village-welfare societies or better-living societies

and sugarcane-growers' societies ". There was no appreciable recovery in the credit movement, membership fell and there was a slight increase in hopelessly deteriorated societies. Overdues in the principal and interest increased both in societies and Central Banks. Only ten banks were able to collect more than ten per cent of their total demand on account of principal. The Provincial Co-operative Bank got into difficulties and had to be helped by Government with a loan of sixteen lakhs and another of four lakhs. A programme of remissions along with carefully regulated fresh finance is being attempted. Lack of inspecting staff was a long standing weakness of the co-operative structure in this province, and in view of the crisis, Government decided to increase their expenditure on the movement by Rs. 57,000 and the staff has been considerably strengthened. Arrangements were made for its training.

An officer was placed on special duty to study land-mortgage banks in other provinces and to make proposals for Bihar.

A welcome feature was the attention paid to agricultural improvement and rural reconstruction. Thirty-six banks made arrangements for demonstrations in the use of manures and improved varieties of seeds and implements and for their distribution and the extension of remunerative crops like nuts, sugarcane, potatoes, Jaunpur maize, vegetables, etc. Over 300 mills and 800 pans for open-pan manufacture of sugar, gifts of the Government, were distributed to members through the co-operative staff. Village welfare societies increased in number and utility and an important beginning in growers' co-operation was made with the organisation of six cane-growers' societies.

An important event of the year was the new Bihar and Orissa Co-operative Societies Act (Act VI of 1935). The Act tightens the restrictions on borrowings and lendings; it gives the Registrar the power of attachment to prevent fraudulent disposal of property; dues are made realisable as arrears of land revenue, the compulsory allocation to reserve fund is increased from twenty-five per cent to thirty-five per cent, the Registrar is given the power to supersede management, to compel amendment of bye-laws and to

surcharge persons for causing loss by negligence or illegal conduct. To further meet the crisis in Central Banks, an amending act was passed to facilitate compromises between co-operative societies and their creditors. The extent to which these extraordinary powers will be used is yet to be seen, but that the legislature thought them necessary is an index of the crisis which faced co-operative societies.

CENTRAL PROVINCES AND BERAR. Barring three banks in Chhatisgarh Division, it is a depressing tale of decreasing membership, diminishing business and poor recoveries. Commenting on this, the Registrar says, " A new factor that vividly came to notice was the working of a large number of Debt Conciliation Boards, the establishment of which was everywhere the signal for withholding of payments by debtors. In many places the resources of the members are exhausted and their indebtedness has become very heavy so that only a succession of favourable years can enable them to liquidate their liabilities. Increasing demoralisation among members and internal dissensions among honorary workers also contributed to the meagreness of recoveries ". The proportion of overdues of members to the total dues increased from seventy-nine per cent to eighty-four per cent in the Central Provinces, but decreased slightly in Berar from ninety-six per cent to ninety-five per cent. A welcome contrast is the oasis in Chhatisgarh where overdues were only six per cent of the outstandings. The outstanding arrears have to be spread over a number of years and attention was devoted to the problem of raising long-term capital for this purpose. Measures of relief were adopted, keeping in view the demands of financial stability. In Berar, detailed enquiry was made into bad debts, and a scheme of writing off irrecoverable loans from reserve funds was put into operation.

Several central banks had difficulties in meeting the demands of their depositors, and three of them were helped by the Provincial Bank which associated itself with their management. Further extension of such help is limited by the resources of the Provincial Bank.

There were ten land-mortgage banks with a working capital of about Rs. $1\frac{3}{4}$ lakhs; there is no central land-mortgage bank, the

Provincial Co-operative Bank performs these functions. The volume of business done was small and the Registrar notes the interesting fact that the solvent, indebted agriculturist seemed to prefer the money-lender to the bank: " the money-lender is now prepared to give almost the same facilities which the land-mortgage banks give ". Co-operative land-mortgage banking thus appears to have achieved much more by its example than the actual figures of business indicate.

Education and supervision continued under what is known as the group system, which shifts the centre of gravity from the central bank to the primary society, the keynote of the scheme being the organisation of the functions of education and supervision under the control of a Central Board independent of the central banks. Classes were held for the training of members, circle auditors, land-mortgage bank managers, group-officers and assistant group-officers, and there were over 260 " rallies " attended by about 12,000 members of 2,000 societies.

North-West Frontier Province. This province shares its Registrar with the Punjab. The number of agricultural credit societies rose from 470 to 549. Membership also increased, the average membership being twenty-five per society. Average indebtedness fell from Rs. sixty-nine to Rs. sixty-six. The total loans advanced were Rs. 96,000, of which Rs. 49,000 were for the purchase of cattle, an agreeable contrast to the high proportion of loans devoted elsewhere to less productive purposes. Three societies for the consolidation of holdings and fifteen ' better-living ' societies were registered, while the general tendency of enlarging the scope of credit societies by their undertaking various welfare activities was noticeable in this province also. There was continuous propaganda for the use of better seed, improved implements and better methods of agriculture.

An unusual society for the marketing of grapes suffered early losses on account of heavy overhead expenses but has resolved to carry on. Another notable organisation was an Egg Grading Station at Taru Jabba. Educational activities were increased with the funds allotted by the Government of India. Thirty-one

Secretaries' classes were held and were attended by 387 secretaries. There were thirteen Office-bearers' classes for 315 office-bearers. A new feature was the use of broadcasting as a means of co-operative education. Twenty-three lectures on various aspects of co-operation were broadcasted, including some by members of societies themselves. Two societies set up radio sets in their village " offices " and in a third, use was made of the President's set.

ASSAM. The small co-operative movement in this province passed through another year of depression. The total number of agricultural societies was 1,301, of which 1,275 were credit societies. Twenty-five new societies were registered and twenty-four liquidated. There was a diminution in the number of members and in working capital. Overdues in the societies stood at the enormous figure of ninety-four per cent. The Registrar foreshadows an increase in liquidation. There are, however, redeeming features in the direction of the development of subsidiary occupations, such as hand-loom weaving.

Most of the societies had an abnormal fall in their net profits owing largely to the application of the Assam Money-Lenders' Act (VI of 1934). The maximum rate of interest on secured loans under this Act is 12½ per cent and it did not leave a sufficient margin of profit for the village societies.

Little new business was done by the five small Land-Mortgage Banks in this province.

Arrangements were made for training the staff out of the 'education grant' of the Government of India and two Inspectors were deputed to the Punjab for training. On return, these will be employed as Education Inspectors for training the rest of the co-operative staff, official and non-official, and for educating rural directors and secretaries.

BURMA. In the welter of liquidation which has characterised the last eight years, new development was out of question and energy was concentrated on the task of speedily closing down weak societies and reconstructing those which responded to the scheme of reconstruction formulated last year. An additional staff of nine auditors and forty-six supervisors was sanctioned by Government

and attempts were made to "reconstruct" societies, both living and liquidated, by returning lands to members on a rent-purchase basis. One-thousand four-hundred and sixty-one insolvent members were expelled, while 3,155 who had good repaying capacity were retained. Excessive debts were drastically moderated, security was obtained and one pleasing result was the absence of recourse to drastic action under the Revenue Law.

An important step forward was the issue of advances for cultivation expenses with repayment in kind. Finance came from Government and the society after collecting the dues of Government returned the surplus to the member who had deposited the crop with it. Sixteen-thousand rupees were advanced to thirty-seven societies. There were no arrears. "The new model bye-laws of co-operative credit and marketing societies, though much stricter in application than those of the old societies, were acclaimed as affording a solution to the defects of the past and applications for societies on the new model were received from all quarters". The success of this scheme of confining credit to cultivation needs and linking it with pledge of produce is perhaps a pointer to the lines on which future development will take place.

Only one hundred and ninety-two societies were reconstructed during the year; more rapid progress could not be made for lack of staff. Nearly 40,000 acres of land were in the hands of liquidators awaiting disposal and most of this were worked by the original owners themselves, often without any payment to the liquidator. The Registrar states, "the solution lies in the speedy disposal of the lands back to the original owners under the reconstruction scheme . . . . . Unless the land problem is quickly settled, it may attain uncontrollable proportions."

The number of agricultural credit societies stood at 1,398, an increase of twenty-seven, on account of reconstruction, from last year. Deposits decreased, fresh credit to members was scarce and the average loan per member was less.

Of the 239 cattle-insurance societies, only six functioned.

DELHI. The rural societies continued to give anxiety, though there was some improvement during the year. According to the

Registrar, the better societies are becoming better and the weaker societies decidedly worse, an experience shared by several other provinces also. Two posts of Sub-Inspectors of Co-operative Societies were sanctioned for consolidation of holdings work in Delhi.

HYDERABAD. The number of agricultural societies increased from 2,272 to 2,335. Repayments to banks were stationary. Advances of new loans increased slightly. Outstandings with members in principal and interest fell from Rs. sixty-two lakhs and Rs. thirty lakhs to Rs. 59½ lakhs and Rs. twenty-four lakhs respectively, while collections rose from Rs. twelve lakhs to Rs. nineteen lakhs. A committee of enquiry has been appointed. The general position is summed up thus in the Government review on the Registrar's report; "The history of the period is again mainly one of struggle to maintain the credit of the movement through a period which unfavourable climatic conditions in some parts of the Dominions, combined with economic depression throughout, made one of strain and anxiety".

MYSORE. The same tale of struggle comes from Mysore though the figures indicate an year of some recovery. The policy of weeding out bad institutions and cautious expansion was pursued this year also and resulted in a slight fall of ninety-two in the number of societies. The membership and total turnover are about the same, while there was improvement in recoveries and profits and the proportion of non-productive borrowing has been reduced.

Of the 1,451 societies in the State, 1,370 were credit societies, twenty-three agricultural supply societies, thirty-nine were grain-banks and four were marketing societies. Some of the grain-banks ceased to function and were being wound up. The agricultural supply societies and the marketing societies were dormant.

Overdues gave anxiety in the land-mortgage banks also.

GWALIOR. After the disorganisation of the boom period, when indebtedness increased enormously, there was a severe restriction of credit and a distressing increase in overdues. The last three years have, however, seen a tendency towards reorganisation and recovery which became marked this year. Overdues have been

reduced, average indebtedness is less and more societies are being financed. There was extensive adjustment of societies' debts against their deposits, and the Registrar claims that much has been done to arrest the deterioration which was a characteristic of the post-slump years. The co-operative system of Gwalior he characterises as " co-operation at the surface, capitalism at bottom and chaos in between ".

TRAVANCORE. Of the total demand in principal of Rs. twenty-five lakhs, a little over Rs. five lakhs was collected, while in interest less than Rs. two lakhs out of a demand of Rs. 8½ lakhs were collected. Twenty-seven societies were cancelled and seventeen registered, the number at the end of the year being 1,766. The inadequacy of the arrangements for liquidation prevented further cancellation. Of the new societies, one was for cattle-breeding, one for sale of milk and milk-products, one for rural reconstruction and one was a better-living society.

Overdues loom large in this state also.

COCHIN. The number of agricultural societies was 133. Their membership was 10,631 and the working capital was Rs. 7·72 lakhs. Of these, 130 were credit societies. Overdues were 46 per cent. The non-credit societies were moribund.

BARODA. There were 901 agricultural societies of which 747 were credit societies. Repayments exceeded advances. Overdues were forty-five per cent. The agricultural non-credit societies included seventy-four societies for consolidation of scattered holdings and seventeen for cotton sale. The cotton sale societies had a good year and sold cotton worth over Rs. five lakhs.

The Baroda Land Mortgage Bank advanced Rs. 77,000, the total loans due being Rs. 1,52,000; repayment was regular, and there was appreciable conciliation of the debts. Government assisted it with a land-valuation officer and a grant of about Rs. 2,500.

CHAPTER XII

PUBLICATIONS OF THE AGRICULTURAL DEPARTMENTS

A complete list of the agricultural publications issued in India during the year under review is given in Appendix XIII. A brief summary of the publications of the Central, Provincial and State Departments of Agriculture is given below :

Central Government Publications. The Imperial Council of Agricultural Research continued to publish its following three journals :—

Agriculture and Livestock in India (bimonthly).

The Indian Journal of Agricultural Science (bimonthly).

The Indian Journal of Veterinary Science and Animal Husbandry (quarterly).

The number of original articles published in *Agriculture and Livestock in India* was fifty-five, of which forty-one related to soils and crops and fourteen to animal husbandry subjects. In *The Indian Journal of Agricultural Science*, fifty-two original contributions were published, of which nineteen may be classed as botanical, seven as chemical, one entomological, seven as statistical and eighteen dealt with plant diseases. In addition, six abstracts and research notes were published. Of the twenty-four original articles which appeared in *The Indian Journal of Veterinary Science and Animal Husbandry*, twelve dealt with animal diseases, eleven with animal nutrition and one with dairying. Arrangements were made to include in this Journal abstracts of articles selected from foreign journals which are likely to be of use to Indian field-workers. The number of abstracts published during the year was six.

The following Scientific Monographs and Miscellaneous Bulletins of the Imperial Council of Agricultural Research were published during the year :—

Scientific Monograph No. 10. The Spotted Boll-worms of Cotton, *Erias fabia* Stoll. and *Erias insulana* Boisd. in South Gujarat, Bombay Presidency, by B. P. Deshpande, M.Ag., and N. T. Nadkarny, B.Ag. (Final report on the Indian Central Cotton Committee's Research Scheme).

Miscellaneous Bulletins—

No. 5. List of publications on Indian Entomology for 1933, by the Officiating Imperial Entomologist, Pusa.

No. 6. Bee-keeping, by C. C. Ghosh, B.A., F.R.E.S. (Revised edition of Pusa Bulletin No. 46).

No. 7. List of publications on Indian Entomology for 1934, compiled by the Officiating Imperial Entomologist, Pusa.

No. 8. Selected Clinical Articles.

Four Miscellaneous Bulletins were in the press at the end of the year.

A text-book entitled 'Handbook of Statistics for use in Plant-breeding and Agricultural Problems', by the late Dr. F. J. F. Shaw, was sent to the press during the year. This book was compiled in response to a request from the Advisory Board of the Council, and is intended to provide a guide in the application of statistical methods to agricultural experiments for students in Indian Universities and agricultural colleges and for research workers in Agricultural Departments.

Provincial and State publications. The MADRAS Department of Agriculture issued four bulletins and fourteen leaflets in English and the principal languages of the province. The annual Villager's Calendar was published in English and four provincial languages and 60,300 copies were distributed. The *Madras Agricultural Journal* continued to be issued monthly by the Madras Agricultural Students' Union, with the assistance of the departmental staff.

In BOMBAY, the Department issued three agricultural bulletins and several leaflets. The Poona Agricultural College continued to publish its Magazine and the Deccan Agricultural Association its monthly Marathi magazine the *Shetki aud Shetkhari*. There are also published Kanarese and Gujarati agricultural journals.

In BENGAL, two leaflets were published—one on sugarcane cultivation and the other on the care of stud bulls. A number of leaflets published previously were reprinted and circulated. Several

broadcasts on agricultural subjects given through the Calcutta Broadcasting Station were published in pamphlet form.

In the UNITED PROVINCES, the departmental magazines *Kisan Upkarak* (Hindi) and *Mufidul Mazarain* (Urdu) continued to make good progress both in quality and quantity of material and circulation. The monthly circulation rose from 2,762 in the previous year to 5,299 during the year under review. The departmental leaflets published during the year numbered twenty-five. In addition four bulletins in the general series and eight bulletins in the Fruit series were issued. Nine numbers in the fruit series were rendered into vernacular. The fruit bulletins are reported to be very popular, about 800 copies having been sold from the Saharanpur gardens alone. A triennial report of the results of experimental work carried out at the various agricultural stations and farms were published during the year. The Allahabad Agricultural Institute continued the publication of its quarterly *The Allahabad Farmer.*

In the PUNJAB, the departmental quarterly *Seasonal Notes* continued to issue, and had a wide circulation in the province. The *Lyallpur Agricultural College Magazine* entered on its third year of existence and continued to render useful service. The Department issued five leaflets during the year.

In BURMA, four cultivators' leaflets were issued embodying the practical recommendation of the department.

In BIHAR, two bulletins were issued dealing with the cultivation of sugarcane and two leaflets on compost-making and irrigation by a power-pumping plant. The Hindi monthly *Kisan*, issued by the Bihar Agricultural Association, is reported to be very popular with the agriculturists in the province.

In the CENTRAL PROVINCES, the department issued three pamphlets and four leaflets in English and the provincial languages. The *Nagpur Agricultural College Magazine* continued to issue quarterly.

In ASSAM, the department issued two bulletins. The SIND Department published seven leaflets in English and Sindhi and started a new series of ' Cultivators Leaflets ' in which the material was presented in a dialogue form. Three such leaflets were issued during the year.

In HYDERABAD, seven leaflets were published. The Hyderabad Farming Association continued to issue its quarterly *The Hyderabad Farmer* in English, Urdu and Telugu. The English quarterly and Kannada monthly published by the Agricultural and Experimental Union, MYSORE continued to appear regularly. The Mysore Department issued an Agricultural Calendar in English and Kannada, three bulletins and two circular leaflets.

In BARODA, the annual Agricultural Calendar and a number of leaflets were publsihed. Seven leaflets were issued in TRAVANCORE and twelve in COCHIN, all dealing with the recommended improvements of the departments.

GENERAL PUBLICITY

All Agricultural Departments in India made an increasing use of the leading newspapers and monthly magazines in English and the Indian languages to bring up-to-date agricultural information to the notice of the educated public. On various occasions radio-talks were also given.

CHAPTER XIII

RECEIPTS AND EXPENDITURE OF THE AGRICULTURAL AND VETERINARY DEPARTMENTS

The financial aspects of the agricultural and veterinary departments of the Central, Provincial and State governments during 1935-36 are summarised in Statements I and II appended to this chapter. The expenditure of the agricultural departments in Provinces and States include the expenditure on animal husbandry also, except in the Punjab where such expenditure is borne by the Civil Veterinary Department. Statement III shows separately the expenditure on animal husbandry in the several provinces and states.

The total gross expenditure of the Central and Provincial departments of agriculture has risen from Rs. 123·4 lakhs in 1934-35 to 137·7 lakhs in 1935-36. Similarly, the total gross expenditure of the Central and Provincial Veterinary departments has increased to Rs. 62·2 lakhs from Rs. 59·4 lakhs in the previous year. While it is gratifying that many departments have been able to show modest increases in expenditure during the period under report, almost all the Provincial reports draw attention to the inadequacy of the existing budget allotments to meet the agricultural and veterinary needs of the country. Extension of research and propaganda is essential in all Provinces and States, and it is hoped that with the general awakening of public interest in the agricultural advancement of the country, the necessary funds will be forthcoming. Fortunately, the grants for research work made by the Imperial Council of Agricultural Research and the grants for cotton research and seed distribution schemes made by the Indian Central Cotton Committee have enabled valuable progress to be made in several directions, and the various departmental reports gratefully acknowledge the assistance of these two bodies. Generous acknowledgments are also made to the valuable financial assistance provided to the provincial agricultural and veterinary departments from the Central Government Grant for Rural Development.

STATEMENT I

Receipts and Expenditure of the Agricultural Departments in India for 1934-35 and 1935-36

	1934-35		1935-36	
	Receipts	Expenditure	Receipts	Expenditure
British India				
	Rs.	Rs.	Rs.	Rs.
Imperial Department of Agriculture	2,02,106	9,68,471	93,393	6,75,322(*a*)
Madras	1,82,436	18,44,341	1,91,168	18,57,827
Bombay Presidency, proper	2,10,731	10,86,257	2,06,698	11,69,996(*b*)
Sind	53,044	3,98,425	43,655	3,85,756
Bengal	86,672	9,35,000	66,794	8,94,444
United Provinces	3,63,990	19,89,495	3,82,807	20,84,701
Punjab	5,93,168	22,16,122	9,50,684	35,38,803
Burma	1,46,866	8,15,236	1,48,432	8,29,165
Bihar and Orissa	1,13,054	5,67,398	1,85,530	6,65,880
Central Provinces	2,35,174	9,83,185	2,18,020	10,30,196
Assam	58,479	3,97,786	56,315	4,40,486
N. W. F. Province	51,947	1,00,000	71,700	1,57,231
Baluchistan	3,701	41,452	2,511	43,542
TOTAL	23,01,368	1,23,43,168	26,17,707	1,37,73,349
Indian States				
Hyderabad	35,000	9,18,000	35,000	9,23,300
Mysore	1,55,967	5,46,960	..	..
Baroda	39,557	2,00,625	33,972	2,98,004
Travancore	17,530	1,43,429	9,043	1,33,073
Cochin	17,337	90,080	16,970	86,392
Bhopal	2,347	32,613	15,009	64,011
Jammu and Kashmir	65,000	1,18,000	70,000	1,22,800
TOTAL	3,32,738	20,50,607	1,79,994	16,28,480

(*a*) Figures for 1935-36 are exclusive of the sections of Physiological Chemist and the Imperial Dairy Expert, which have been separated from the Imperial Agricultural Research Institute.

(*b*) Excludes grants received from the Imperial Council of Agricultural Research (Rs. 1,48,164), the Indian Central Cotton Committee (Rs. 1,27,281), Sir Sasson David Trust Fund (Rs. 14,893) and the Imperial Allotments (Rs. 7,953).

STATEMENT II

Receipts and Expenditure of the Civil Veterinary Departments in India during 1934-35 and 1935-36

	1934-35		1935-36	
	Receipts	Expenditure	Receipts	Expenditure
British India				
	Rs.	Rs.	Rs.	Rs.
Madras	47,079	9,31,737	49,830	9,79,272
Bombay Presidency, proper	17,869	4,74,893	21,199	4,87,889
Sind	341	1,06,463	366	1,13,720
Bengal	1,28,437	4,60,118	1,29,870	4,87,611
United Provinces	1,26,226	4,12,101	1,29,020	4,27,341
Punjab	28,749	10,09,743	27,372	10,37,343
Burma	23,009	4,40,041	2,032	4,71,134
Bihar and Orissa	1,21,049	6,07,067	1,73,460	7,31,063
Central Provinces	1,670	3,93,940	1,973	4,05,508
Assam	1,188	1,79,442	1,342	1,83,097
N. W. F. Province	4,610	1,15,981	4,842	2,13,427
Imperial Institute of Veterinary Research	5,78,725	6,41,609	5,41,411	5,88,255
TOTAL	10,78,952	58,44,752	10,82,717	61,25,660
Baluchistan	..	65,416	..	63,686
Coorg	64	17,617	62	18,473
Ajmer-Merwara	6,027	7,627	2,862	10,764
TOTAL	6,091	90,660	2,924	92,923
Indian State				
Hyderabad	9,640	4,83,222	10,557	4,94,780
Mysore	17,753	2,57,885	1,328	2,27,950
Travancore	359	32,159	230	35,084
Baroda	1,627	74,631	1,075	79,651
Cochin	..	28,528	..	31,367
Bhopal	9,089	9,089	9,523	9,523
TOTAL	38,468	8,85,514	23,613	8,79,264

STATEMENT III

Showing Receipts and Expenditure on Animal Husbandry in Provinces and States in India during 1935-1936

Name of the Province or State	1934-35		1935-36	
	Receipts	Expenditure	Receipts	Expenditure
British India				
	Rs.	Rs.	Rs.	Rs.
Madras	29,870	1,02,104	32,030	82,970
Bombay	71,358	1,35,867	73,699	1,39,998
Bengal	6,606	54,246	6,280	62,452
United Provinces	..	..	..	(a)
Punjab	99,162	9,70,761	98,984	9,85,680
Burma	2,867	3,617	2,460	3,831
Bihar and Orissa	..	..	..	(a)
Central Provinces	53,108	96,732	47,416	98,871
Assam	17,645	1,06,800	20,147	1,12,975
N. W. F. Province	..	..	..	(a)
Sind	..	..	..	(a)
Baluchistan	..	..	..	(a)
Indian States				
Hyderabad	11,345	46,874	19,562	47,404
Baroda	10,872	67,886	10,585	75,005
Travancore	359	32,159	230	35,984
Bhopal	9,089	9,089	9,527	9,527
Jammu and Kashmir	..	6,800	..	6,500
Cochin	326	743	345	809

(a) Information not available.

APPENDICES

APPENDIX I

Areas under new and improved varieties of crops in India during 1935-36

Name of Province or State	Name of crop	Area in acres					
		1934-35			1935-36		
		Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total
Madras	Paddy	202,335	726,506	928,841	31,411*	1,031,888	1,063,299
	Cotton	63,596	425,910	489,506	70,268	547,674	617,942
	Sugarcane	12,480	45,463	57,943	9,012	49,037	58,049
	Miscellaneous	9,188	63,811	72,999	9,016	196,039	205,055
Bombay	Cotton (1027ALF, Wagad 8, Jayawant, Gadag 1, Banila, NR, BD 8).	363,051	254,173	617,224	405,983	286,634	692,617
	Groundnut	2,088	467,760	469,848	322	52,175	55,497
	Wheat (Pusa 4, wheat 808, 224, 168 and 162).	3,378	38,773	42,151	5,559	20,312	25,871
	Sugarcane	270	10,800	11,070	110	13,850	13,960
	Bajra (Akola)	4,346	33,601	37,947	16,914	131,532	148,446
	Paddy	2,799	12,615	15,414	4,303	9,221	13,524
	Tobacco (Nos. 6, 28)	803	2,730	3,533	880	2,500	3,380
	Nagli	146	1,710	1,856	225	3,500	3,725
	Jowar	588	800	1,388	2,036	2,160	4,196
	Potato	100	400	500	55	50	105
	Sann seed	..	..	..	726	1,396	2,122
	Soya Beans	..	..	..	36	23	59
	Lucerne	..	..	..	100	1,903	2,003

	Nilwa	..	..	..	29	105	134
	Fruit	309	3,852	4,161	595	4,568	5,163
Bengal	Paddy	14,928	501,238	516,166	6,620	695,506	702,126
	Jute	2,265	1,134,337	1,136,602	430	1,103,496	1,103,926
	Sugarcane	1,876	168,885	170,762	3,745	273,577	277,322
	Other minor crops	1,675	11,642	13,318	2,086	15,961	18,047
United Provinces	Wheat	190,000	2,260,000	2,450,000	187,000	2,450,000	2,637,000
	Cotton	28,000	329,000	357,000	40,000	357,000	397,000
	Sugarcane	72,500	1,598,500	1,671,000	120,000	2,047,000	2,167,000
	Barley	25,000	56,500	81,500	23,000	81,500	104,500
	Gram	18,000	113,200	131,200	21,000	131,200	152,200
	Miscellaneous	24,000	243,000	267,000	20,000	267,000	287,000
Punjab	Cotton	342,000	1,273,700	1,615,700	513,000	1,563,100	2,076,100
	Wheat	150,350	3,098,950	3,249,300	243,600	583,200	3,476,800
	Sugarcane	2,350	198,250	200,600	5,000	221,300	226,300
Burma	Paddy	311,348	721,167	1,032,515	183,863	874,921	1,058,784
	Ground-nut	284	27,150	27,434	651	21,056	21,707
	Gram	1,352	144,620	145,972	4,298	170,163	174,461
	Wheat	80	15,995	16,075	140	24,150	24,290
	Cotton	3,899	1,800	5,699	4,212	1,472	5,684
	Jowar	714	300	1,014	1,060	2,627	3,687

* The reduction in the area under paddy is due to the fact that the actual quantity of seed supplied by the Department from the farms and depots alone has been taken into consideration and the area calculated on this is given; whereas in 1934-35 by mistake was included the area under natural spread also.

Areas under new and improved varieties of crops in India during 1935-36—contd.

Name of Province or State	Name of crop	Area in acres					
		1934-35			1935-36		
		Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total
Burma—*contd.*	Butter Beans	514	5,961	6,475	650	5,406	6,056
	Pesinngon	428	48,392	48,820	4,103	79,560	83,663
	Sugarcane	218	13,093	13,311	288	15,909	16,197
	Sesamum	6,720	12,295	19,015	2,592	21,720	24,312
	Matpe	..	..	..	155	300	455
	Red Onion	..	..	..	..	1,515	1,515
	Kew Pineapple	..	..	..	3	..	3
	Miscellaneous	..	..	..	1,151	5,223	6,374
Bihar and Orissa	Sugarcane	..	..	358,363	1,348	327,020	420,832
	Wheat	3,735	50,607	54,342	3,180	49,281	64,329
	Paddy—						
	Dahia[1] (Kanke II, Kankesal, Latisal, Orissa Nos. 1, 2, 3, 5, Kujang No. 1 Badshabhog, Benibhog, Kalajiri, Biradi Bankoi, Khurda No. 1).	1,457	34,216	35,673	807	42,348	52,849
	Jute (D 154 and G. O.)	..	..	1,014	3	1,200	1,203
	Barley (Pusa 21)	241	5,500	5,741	383	5,867	6,250
	Groundnut	227	2,260	2,487	298	1,069	3,009
	Tobacco	5	150	155	2	500	502
	Gram (Sabour 4, Pusa 17)	486	3,728	4,214	315	4,370	5,246

	Miscellaneous (Pusa Linseed 12, peas 55 and 10, Elephant grass, *Rahar*, Potato, Onion, *Juar*, Maize, Pea, Ginger, gingili, *sonamung*, garlic, khesari, Dhaincha, Lentil, Potal and Vegetables).	697	7,908	8,646	350	1,775	2,125
Central Provinces and Berar	Wheat	..	..	572,399	.	..	590,025
	Rice	..	..	528,556	..	..	585,888
	Cotton	..	..	441,498	..	..	505,327
	Jowar	..	..	150,557	..	..	178,103
	Ground-nut	..	..	111,568	..	..	105,832
	Other crops	..	..	38,659	..	..	81,609
Assam	Rice	2,329	28,488	30,817	2,227	40,382	42,609
	Sugarcane	23	7,813	7,836	33	14,465	14,498
	Potato	533	4,888	5,421*	190	5,709	5,899
	Jute	37	20,645	20,682*	*Nil*	15,890	15,890
North-West Frontier Province	Wheat	14,943	11,000	25,943	9,844	5,200	15,044
	Maize	4,360	3,000	7,360	2,605	20	2,625
	Sugarcane	45	..	45	116	32	148
	Gram	..	..	..	16	..	16
	Cotton	200	100	300	400	500	900
	Potato	..	..	..	1	15	16
Sind	Cotton	52,189	174,068	226,257*	114,672	488,887	603,559
	Wheat	18,651	55,300	73,951*	37,872	50,704	88,576
	Rice	822	28,795	29,617*	1,780	54,985	56,765
	Miscellaneous crops	5,406	7,378	12,784*	6,241	12,995	19,236

* Revised figures.

Areas uner new and improved varieties of crops in India during 1935-36—contd.

Name of Province or State	Name of crop	AREA IN ACRES					
		1934-35			1935-36		
		Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total
Baluchistan	Wheat (AT 38, CP 47)	*Nil*	*Nil*	*Nil*	670 mds.	900	900
Hyderabad	Sugarcane	131	14,228	14,359	670	16,883	17,553
	Ground-nut	959	38,437	39,396	1,243	35,020	36,263
	Bajra	464	1,360	1,824	470	1,155	1,625
	Wheat	307	515	822	726	746	1,472
	Paddy	643	2,689	3,332	460	1,305	1,765
	Jowar	63	..	63	175	..	175
	Cotton	17,044	2,630	19,674	53,700	2,390	56,090
	Castor	..	..	..	400	..	400
	Potatoes	..	..	..	1	..	1
	Guinea grass	..	..	..	3	..	3
	Dhaincha	..	..	..	1	..	1
	Paddy	17,918	64,909	82,827*	4,716	72,103	76,819
	Ragi	11,731	392,802	404,533*	8,812	320,218	339,030
	Sugarcane	12,168	5,731	17,899*	13,405	5,868	19,273
	Ground-nut	836	41,729	42,565*	1,406	27,727	29,133
	Sann-hemp	20	260	280	25	100	125
	Tobacco	1	..	1	300	..	300
	Jola	665	..	665	15	2,495	2,510

Mysore	Cotton	15,334	986	16,320	3,421	9,263	1,84¢
	Vegetable seeds	10	10	20	..	..	..
	Pepper cuttings	¼	10	10¼	..	..	..
	Chillies	..	..	..	1	5	6
	Soya beans	..	..	..	6	..	6
	Potatoes	..	2	2	..	..	..
	Java wheat	..	..	..	2	..	2
Baroda	Cotton (1027 A L F, B9, wagad 8 and Dh 1).	28,125	..	28,125	79,930	7,285	87,215
	Wheat (Pusa 4)	100	14,284	14,384	42	15,000	15,042
	Rice	100	..	100	100	..	100
	Ground-nut	..	..	..	315	..	315
Travancore	Paddy	710	..	710	311	..	311
Cochin	Paddy	126	4,088	4,214	3	3,999	4,002
	Sugarcane	1	12	13	2	62	64
	Cotton	..	5,737	5,737	..	4,798	4,798
	Pineapple	..	50	50	..	50	50
	Coconuts	16	..	16	9	37	46
	Ground-nut	..	..	..	..	1	1
Bhopal	Cotton	..	..	..	10	5	15
	Paddy	..	..	..	1	5	6
	Wheat	121	4,812	4,933	1,500	19,732	21,232
	Gram	28	..	28	302	200	502
	Linseed	⅛ 12	..	12	110	200	310
	Til	51	..	51	31	510	541

*Revised figures.

Areas under new and improved varieties of crops in India during 1935-36—contd.

Name of Province or State	Name of crop	Area in acres					
		1934-35			1935-36		
		Departmental seed	Natural spread	Total	Departmental seed	Natural spread	Total
Bhopal—*contd.*	Sugarcane	13,830	..	13,830	1,600	..	1,600
	Ground-nut	1	..	1	7	18	17
	Lentil	..	..	..	5	20	25
	Castor	..	..	..	10	250	260
	Arhar	..	..	..	20	10	30
	Peas	..	..	..	20	10	30
	Tobacco	..	..	..	5	20	25
Jammu and Kashmir	Rice	486	2,000	2,486	450	8,000	8,450
	Wheat	500	1,500	2,000	272	10,000	10,272
	Barley	40	..	40	12	100	117
	Indian Corn	1,272	8,000	9,272	900	20,000	20,900
	Sugar Corn	244	500	744	171	700	871
	Oilseeds	209	..	209	38	200	238
	Potatoes	27	100	127	24	500	524
	Beans	8	100	108	73	200	273
	Peas	172	250	422	79	400	479
	Sugarcane	25	1,000	1,025	40	2,500	2,540
	Miscellaneous crops	250	..	250	200	500	700
	Vegetable seeds	250	500	750	400	1,000	1,400

APPENDIX II

List of Agricultural Stations in India in 1935-36

Province or State.	Agricultural Station	Area in acres	Officer in immediate charge	Supervising officer	Remarks
Imperial Departments of Agriculture and Dairying in India.	Pusa	750*	Assistant Agriculturist	Imperial Agriculturist	Imperial Agricultural Research Institute, New Delhi. * Cultivated area.
	Karnal	145	Farm Superintendent	Imperial Economic Botanist	Botanical Sub-station, financed by I. C. A. R.
		30	Assistant	Sugarcane Expert	Sugarcane Sub-station, financed by I. C. A. R.
		1,086*	Superintendent	Imperial Dairy Expert	Cattle-breeding farm. * Cultivated area.
	Coimbatore	90	Farm Manager	Sugarcane Expert	Cane-breeding Station.
Madras	Berhampore	33	Superintendent	Paddy Specialist, Coimbatore.	
	Samalkota	57	Farm Manager	Deputy Director of Agriculture, Vizagapatam.	
	Anakapalle	104	Superintendent	Director of Agriculture.	
	Maruteru	50	Ditto	Paddy Specialist.	
	Guntur	150	Farm Manager	Deputy Director of Agriculture, Guntur.	
	Hagari	225	Ditto	Deputy Director of Agriculture, Bellary.	
	Nandyal	88	Ditto	Ditto.	
	Anantarajupeta	50	Superintendent	Ditto.	
	Gudiyattam	85	Farm Manager	Superintendent, Anakapalle.	
	Kalahasti	30	Ditto	Deputy Director of Agriculture, St. Thomas Mount.	
	Erayanur, Tindivanam	49	Ditto	Oil-Seeds Specialist, Coimbatore.	

List of Agricultural Stations in India in 1935-36—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising officer	Remarks
Madras	Palur	52	Farm Manager	Deputy Director of Agriculture, St. Thomas Mount.	
	Aduthurai	50	Superintendent	Deputy Director of Agriculture, Trichinopoly.	
	Pattukottai	36	Farm Manager	Ditto,	
	Kollpatti	140	Superintendent	Deputy Director of Agriculture, Madura.	
	Pattambi	82	Ditto	Paddy Specialist.	
	Taliparamba	86	Farm Manager	Deputy Director of Agriculture, Tellicherry.	
	Kasaragod and Nileswar	178	Ditto	Oil-Seeds Specialist.	
	Nanjanad	160	Superintendent	Deputy Director of Agriculture, Coimbatore.	
	Coonoor, Burliar and Kallar	30	Farm Manager	Curator.	Pomological Station.
	Coimbatore	400	Superintendent	Principal, Coimbatore.	
	Hosur	1,660	Ditto	Deputy Director of Agriculture, Livestock.	
	Jalgaon Farm	107	Superintendent, Jalgaon Farm.	Deputy Director of Agriculture, N. C. D., Nasik.	
	Bhadgaon Farm	209	Superintendent, Bhadgaon Farm.	Ditto.	Financed from the funds of the Indian Central Cotton Committee, Bombay.
	Dhulia Agricultural School	28	Head Master, Vernacular Agricultural School, Dhulia.	Ditto.	
	Karjat Farm	15	Rice Specialist, Karjat	Ditto.	

Bombay	Kopargaon	110†	Superintendent, Kopergaon Farm.	Deputy Director of Agriculture, S. C. D., Poona.	Sugarcane Experimental Station.
	Ratnagiri	22	Superintendent, Ratnagiri Farm.	Ditto	Rice and *Nagli* Breeding Station.
	Mohol	55	Superintendent, Mohol Farm.	Ditto	This farm is maintained for testing and showing the methods of dry cultivation land development in famine and *jowar* breeding work.
	Government Agricultural Station, Dharwar.	146	Superintendent	Deputy Director of Agriculture, S. D., Dharwar.	
	Gokal Canal Farm at Arbhavi, District Belgaum.	62	Ditto	Ditto.	
	Government Agricultural Station, Kumta, District North Kanara.	68	Ditto	Ditto.	
	Rice Breeding Station, Mugad, District Dharwar.	9	Rice-Breeder	Ditto.	
	Cattle Breeding Farm, Tegur, District Dharwar.	370	Agricultural Sub-Overseer	Ditto.	
	Surat	294	Superintendent, Agricultural Station, Surat, and Cotton-Breeder, S. G., Surat.	Deputy Director of Agriculture, Surat.	Research and experiments in cotton, *jowar* breeding, cultural and manurial experiments in cotton and *jowar* and maintaining and multiplying pure seeds for distribution.
	Tobacco and *Bajri* Research Station, Nadiad.	15	Tobacco Breeder, Nadiad	Ditto	Improvements of local varieties of tobacco and *bajri* by breeding the best strain and multiplying their pure seeds for distribution. Also evolving new varieties suitable for cigarette-making.

† The total area of the farm is 110 acres; out of this 40 acres were under cultivation during the year 1935-36, 60 were leased to the Banilla Cotton Scheme, 6 acres were occupied by buildings, roads, etc., and 4 acres lay uncultivable waste.

List of Agricultural Stations in India in 1935-36—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising officer	Remarks
Bombay	Broach	22	Superintendent, Broach Farm, and Cotton-Breeder, Broach.	Deputy Director of Agriculture, Surat.	Breeding cotton, *jowar* and wheat types best suited to Broach tract. Breeding wilt-resistant type of cotton combined with their economic characters.
	Dohad	68	Superintendent, Dohad Farm.	Deputy Director, Gujarat, Surat.	Improving staple crop of maize, wheat and groundnut and multiplying seeds for distribution. Demonstration of improved cultural methods to Bhil cultivators.
	Cotton and *Jowar* Breeding Station, Viramgam.	18	Cotton Breeder, North Gujarat, Viramgam.	Deputy Director of Agriculture, Gujarat, Surat.	Improvement in local types of wagad cotton and *jowar* by breeding.
	Agricultural College Farm, Poona	275	The Superintendent, Agricultural College Farm, Poona.	Professor of Agriculture, Poona.	
	Agricultural College Dairy, Kirkee	362	The Manager, Agricultural College Dairy, Kirkee.	Ditto.	
	Rice Breeding Station, Karjat, District Kolaba.	6	Superintendent	Crop Botanist to Government of Bombay, Karjat, Kolaba District.	
	Cereal Breeding Station, Niphad, District Nasik.	18	Ditto	Ditto.	
	Northcote Cattle Breeding Farm, Chharodi, District Ahmedabad.	2,278	Manager	Live-stock Expert to Government, Bombay Presidency, Poona.	
	Cattle Breeding Farm, Bankapur, District Dharwar.	(1) 96 (2) 152	Ditto	Ditto	(1) Farm area. (2) Grazing area at Kalesgiri attached to the Farm.
	Ganeshkhind Fruit Experiment Station, Kirkee.	80	The Superintendent, Ganeshkhind Fruit Experiment Station, Kirkee.	Horticulturist to Government, Bombay Presidency, Poona.	This is now converted into a commercial Fruit Farm.
	Modibag Agricultural College, Poona	12	The Superintendent, Modibag, Agricultural College, Poona.		
	Samarkha *vid* Anand, District Kaira	223	Investigator in Agricultural Economics, Agricultural College, Poona.	Professor of Agricultural Economics, Agricultural College, Poona.	Cost accounting of mixed farming with live-stock raising.

Bengal	Chinsurah	210	Farm Superintendent		
	Berhampore	44	District Agricultural Officer, Murshidabad.		
	Bankura	29	District Agricultural Officer, Bankura.		
	Suri	35	District Agricultural Officer, Birbhum.		
	Krishnagar	53	District Agricultural Officer, Nadia.	Deputy Director of Agriculture, Western Circle.	
	Burdwan	35	District Agricultural Officer, Burdwan.		
	Jessore Khasmahal	5	District Agricultural Officer, Jessore.		
	Gosaba	12	Agricultural Officer, Gosaba		
	Rajshahi	93	Farm Superintendent, Rajshahi.		
	Pabna	19	District Agricultural Officer, Pabna.		
	Bogra (Main)	23	District Agricultural Officer, Bogra.	Deputy Director of Agriculture, Northern Circle.	
	Bogra (Braneh)	6			
	Malda	19	District Agricultural Officer, Malda.		
	Dinajpur	24	District Agricultural Officer, Dinajpur.		
	Rangpur Demonstration Farm	19	District Agricultural Officer, Rangpur.		
	Mainaguri	23	District Agricultural Officer, Jalpaiguri.		
	Rangpur Tobacco Farm	72	Farm Superintendent	Assistant Director of Agriculture, Bengal.	
	Kalimpong Farm	73	Superintendent of Agriculture, Darjeeling.	Director of Agriculture, Bengal.	
	Rangamati Farm	30	District Agricultural Officer, Chittagong Hill Tracts.		
	Dacca Central Farm	354	Chief Superintendent, Dacca Farm.	Deputy Director of Agriculture, Eastern Circle.	
	Joydevpur C. W. Farm	7	Demonstrator		

List of Agricultural Stations in India in 1935-36—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising officer	Remarks
Bengal	Mymensingh Farm	20	District Agricultural Officer, Mymensingh.	Deputy Director of Agriculture, Eastern Circle.	
	Jamalpur Farm	34	Ditto		
	Kishoreganj Farm	88	Ditto		
	Dhanbari Farm	6	Ditto		
	Gayhatta C. W. Farm	6	Demonstrator		
	Faridpur Farm	20	District Agricultural Officer, Faridpur.		
	Rajbari Farm	9	Ditto		
	Barisal Farm	20	District Agricultural Officer, Barisal.		
	Charbadna Farm	59			
	Comilla Farm	20	District Agricultural Officer, Comilla.		
	Baratia Private Farm	9	Demonstrator		
	Brahmanbaria (Private)	5	Agricultural Demonstrator		
	Shahjahanpur	165	Superintendent	Economic Botanist, Sugarcane and Paddy, to Government, United Provinces.	
	Nagina (Bijnor)	77	Research Specialist	Ditto.	
	Budaun	20	Farm Superintendent	Deputy Director of Agriculture, Rohilkhand and Kumaon Circle, Bareilly.	
	Nawabganj (Bareilly)	120	Ditto	Ditto.	
	Nigohi Farm	30	Ditto	Ditto.	
	Jeolikote	51	Ditto	Ditto.	
	Tarikhet	17	Ditto	Ditto.	

United Provinces	Atarra (Banda)	171	Ditto	Divisional Superintendent of Agriculture, Bundelkhand Circle.
	Bela Tal (Hamirpur)	30	Ditto	Ditto.
	Etawah	61	Ditto	Ditto.
	Bichpuri (Agra)	100	Ditto	Ditto.
	Fyzabad	206	Ditto	Deputy Director of Agriculture. Eastern Circle, Partabgarh.
	Partabgarh	90	Ditto	Assistant Deputy Director of Agriculture, Eastern Circle.
	Benares	78	Ditto	Divisional Superintendent of Agriculture, Eastern Circle.
	Kalai (Aligarh)	143	Ditto	Deputy Director of Agriculture, Western Circle.
	Bulandshahr	25	Ditto	Ditto.
	Muzaffarnagar	101	Ditto	Assistant Deputy Director of Agriculture, Western Circle.
	Meerut	76	Ditto	Ditto.
	Mainpuri	53	Ditto	Divisional Superintendent of Agriculture, Western Circle.
	Gorakhpur	110	Ditto	Deputy Director of Agriculture, North-Eastern Circle, Gorakhpur.
	Bahraich	102	Ditto	Divisional Superintendent of Agriculture, North-Eastern Circle.
	Kallanpur (Cawnpore)	263	Ditto	Deputy Director of Agriculture, Sarda Circle, Lucknow.
	Hardoi	55	Ditto	Divisional Superintendent of Agriculture, Sarda Circle.
	Palhri (Barabanki)	30	Ditto	Assistant Deputy Director of Agriculture, Sarda Circle.
	Haidargarh (Barabanki)	16	Ditto	Ditto.
	Turner (Rai Bareli)	12	Ditto	Ditto.
	Unao	43	Ditto	Ditto.

List of Agricultural Stations in India in 1935-36—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
	Lyallpur Agricultural Station	431	Agricultural Assistant	Deputy Director of Agriculture, Lyallpur.	Experimental Farm.
	Botanical Farm, Lyallpur	40	Cerealist	Cerealist, Punjab Agricultural College, Lyallpur.	Experiments with cereals.
	Cotton Research Station, Lyallpur	18	Assistant to the Cotton Research Botanist, Lyallpur.	Cotton Research Botanist, Lyallpur.	Breeding plot.
	Cotton Research Farm, Risalewala	230	Ditto	Ditto	Agronomic and extensive trials.
	Students' Farm, Lyallpur	82	Assistant Professor of Agriculture, II.	Professor of Agriculture, Lyallpur.	For practical training to students.
	Dairy Farm, Lyallpur	26	Dairy Manager	Ditto	Ditto.
	Botanical Farm, Lyallpur	10	Professor of Botany	Professor of Botany, Punjab Agricultural College, Lyallpur.	For root-rot experiments, spice crops and various diseases.
	Fruit Farm, Lyallpur	28	Agricultural Assistants	Fruit Specialist, Lyallpur	Experiments with fruits.
	Risalewala	743	Agricultural Assistant	Deputy Director of Agriculture, Lyallpur.	Mainly a seed farm.
	Jhang	200	Ditto	Ditto	District Farm.
	Kala Shah Kaku Rice Farm	384	Assistant Cerealist	Ditto	Rice-breeding Station.
	Montgomery Agricultural Station	681	Agricultural Assistant	Deputy Director of Agriculture, Montgomery.	Experimental Farm.
	Shergarh Farm	1,549	Ditto	Ditto	Seed Farm.
	Fatna Farm	528	Ditto	Ditto	Do.
	Multan Farm	528	Ditto	Deputy Director of Agriculture, Multan	Experimental and Seed Farm.
	Vihari Farm	500	Ditto	Ditto	Seed Farm.
	Gurdaspur Agricultural Station	263	Ditto	Deputy Director of Agriculture, Gurdaspur.	Experimental Farm.
	Beas Farm	36	Ditto	Ditto	District Farm.

Punjab	Attari Farm	101	Ditto	Ditto	Ditto.
	Gujranwala Farm	107	Ditto	Ditto	Ditto.
	Rawalpindi Agricultural Station	252	Ditto	Deputy Director of Agriculture, Rawalpindi.	Experimental Station.
	Campbellpur Farm	100	Ditto	Ditto	District Farm.
	Gujrat Farm	47	Ditto	Ditto	Ditto.
	Chillianwala Seed Farm	250	Ditto	Ditto	Seed Farm.
	Sargodha Old Seed Farm	155	Ditto	Ditto	Ditto.
	Sargodha New Seed Farm	492	Ditto	Ditto	Ditto.
	Mianwali Farm	162	Ditto	Ditto	District Farm.
	Hansi Agricultural Station	589	Ditto	Deputy Director of Agriculture, Hansi.	Experimental Station.
	Botanical Sub-Station, Sirsa	393	Millet Botanist and Fodder Specialist.	Professor of Botany, Punjab Agricultural College, Lyallpur.	Botanical Experiments.
	Gurgaon Farm	100	Agricultural Assistant	Deputy Director of Agriculture, Hansi.	District Farm.
	Rohtak Dry Farming Research Station	100	Agriculturist	Ditto	Dry Farming Research Station.
	Ambala Farm	100	Agricultural Assistant	Ditto	District Farm.
	Karnal Farm	100	Ditto	Ditto	Ditto.
	Ludhiana Farm	54	Ditto	Deputy Director of Agriculture, Jullundur.	Ditto.
	Kangra Agricultural Plot	10	Ditto	Ditto	Agricultural Plot.
	Jullundur Agricultural Station	121	Ditto	Ditto	Experimental Farm.
	Ferozepore Farm	100	Ditto	Ditto	District Farm.
Burma	Hmawbi	456	Farm Superintendent	Rice Research Officer, Burma, Rangoon.	
	Mandalay	630	Ditto	Assistant Director of Agriculture, Mandalay.	
	Kanbalu	534	Ditto	Deputy Director of Agriculture, Northern Circle, Mandalay.	

List of Agricultural Stations in India in 1935-36—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising officer	Remarks.
Burma	Mahlaing	254	Farm Superintendent	Deputy Director of Agriculture, Myingyan Circle, Meiktila.	
	Pyinmana	55	Ditto	Deputy Director of Agriculture, East Central Circle, Pyinmana.	
	Tatkon	106	Ditto	Ditto.	
	Allanmyo	144	Ditto	Deputy Director of Agriculture, West Central Circle, Magwe.	
	Sa-aing	11	Ditto	Ditto.	
	Myaungmya	92	Ditto	Deputy Director of Agriculture, Irrawaddy Circle, Bassein.	
	Mudon	88	Ditto	Deputy Director of Agriculture, Tenasserim Circle, Moulmein.	
	Akyab	138	Ditto	Deputy Director of Agriculture, Arakan Circle, Akyab.	
	Kyaukpyu	23	Ditto	Ditto.	
	Paukkoung	16	Ditto	Entomologist, Burma, Mandalay.	
	Sepaya	379	Manager	Deputy Director of Agriculture, North Bihar Range.	
	Siwan	20	Overseer		
	Darbhanga	26	Ditto		
	Purnea	60	Assistant Director of Agriculture	Tournament Trust Farm.	
	Byreah	316	Farm Manager	Manager, Bettiah Raj Court of Wards Farm.	
	Patna	200	Manager	Deputy Director of Agriculture, South Bihar Range.	
	Gaya	95	Overseer	Ditto.	

Bihar and Orissa	Nawadah	88	Ditto	Ditto.
	Bikramganj	24	Ditto	Ditto.
	Siris	35	Ditto	Ditto.
	Kanke	340	Manager	Ditto.
	Neterhat	193	Overseer	Deputy Director of Agriculture, Chota Nagpur Range.
	Purulia	52	Ditto	Ditto.
	Chianki	32	Ditto	Ditto.
	Chaibassa	38	Ditto	Ditto.
	Sabour	150	Manager	Assistant Director of Agriculture, in charge of South-East Bihar Range.
	Jamui	38	Overseer	Ditto.
	Banka	26	Ditto	Ditto.
	Cuttack	150	Manager	Assistant Director of Agriculture, in charge Orissa Range.
	Khurda	31	Overseer	Ditto.
	Balasore	75	Ditto	Ditto.
	Angul	47	Ditto	Ditto.
	Puri	42	Ditto	Ditto.
	Kujang	30	Ditto	Ditto.
	Sambalpur	32	Ditto	Ditto.
Central Provinces and Berar	Experimental Farm, Akola	272	Superintendent	Economic Botanist for Cotton, Central Provinces.
	Experimental Farm, Chhindwara	69	Ditto	Deputy Director of Agriculture.
	Experimental Farm, Powarkhera (Hoshangabad).	528	Ditto	Ditto.
	Experimental Farm, Adhartal (Jubbulpore District).	209	Ditto	Ditto.
	Experimental Farm, Nagpur	286	Ditto	Principal, Agricultural College, Nagpur.

List of Agricultural Stations in India in 1935-36—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
Central Provinces and Berar	Experimental Farm, Labhandi (Raipur District).	229	Superintendent . .	Deputy Director of Agriculture.	
	Seed and Demonstration Farm, Waraseoni.	63 (cropped area).	Ditto . . .	Ditto.	
	Seed and Demonstration Farm, Betul	160	Ditto . . .	Ditto.	
	Seed and Demonstration Farm, Bilaspur.	253	Ditto . . .	Ditto.	
	Seed and Demonstration Farm, Buldana.	135	Ditto . . .	Ditto.	
	Seed and Demonstration Farm, Drug	281	Ditto . . .	Ditto.	
	Seed and Demonstration Farm, Khandwa (Nimar District).	177	Ditto . . .	Ditto.	
	Seed and Demonstration Farm, Chand Khuri (Raipur District).	111	Ditto . . .	Ditto.	
	Seed and Demonstration Farm, Seoni (Chhindwara District).	170	Ditto . . .	Ditto.	
	Seed and Demonstration Farm, Yeotmal.	106	Ditto . . .	Ditto.	
	Seed and Demonstration Farm, Saugor.	161	Ditto . . .	Ditto.	
	Cattle-Breeding Farm, Drug . .	..	Ditto . . .	Ditto . . .	This farm is attached to the Demonstration Farm, Drug.
	Cattle-Breeding and Dairy Farm, Ellichpur.	300	Ditto . . .	Extra Assistant Director in charge of Animal Husbandry.	
	Cattle-Breeding Farm, Powarkhera .	..	Ditto . . .	Deputy Director of Agriculture	Attached to the Experimental Farm, Powarkhera.
	Cattle-Breeding Farm, Adhartal .	339	Ditto . . .	Ditto.	
	Cattle-Breeding and Dairy Farm, Telinkheri.	1,000	Ditto . . .	Extra Assistant Director in charge of Animal Husbandry.	

	Cattle-Breeding Farm, Chandkhuri	..	Ditto	Deputy Director of Agriculture	Attached to the Demonstration Farm, Chandkhuri.
	Cattle-Breeding Farm, Khandwa	..	Ditto	Ditto	Attached to the Demonstration Farm, Khandwa.
	Cattle-Breeding Farm, Garhi	1,617	Ditto	Extra Assistant Director in charge of Animal Husbandry.	
	Cattle-Breeding Farm, Pendra	2,500	Ditto	Ditto.	
	Cattle-Breeding Farm, Bod	2,906	Ditto	Ditto.	
	Cattle-Breeding Farm, Borgaon	379	Ditto	Deputy Director of Agriculture.	
	Cattle-Breeding Farm, Bilaspur	..	Ditto	Ditto	Attached to the Demonstration Farm, Bilaspur.
Assam	Upper Shillong Experimental Station	521	Farm Manager	Deputy Director of Agriculture, Live-stock.	Cattle-breeding, potato and fodder crops.
	Khanapara Cattle Breeding Farm	197	Ditto	Ditto	Cattle-breeding and fodder crops.
	Sylhet Cattle Breeding Farm	210	Ditto	Ditto	Ditto.
	Jorhat Experimental Station	59	Ditto	Deputy Director of Agriculture, Live-stock, Upper Assam Valley.	Cattle-breeding and sugarcane.
	Titabar Experimental Station	125	Ditto	Economic Botanist, Assam	Rice.
	Karimganj Experimental Station	80	Ditto	Deputy Director of Agriculture, Surma Valley.	Do.
	Deep Water Paddy Research Farm, Habiganj.	54	Economic Botanist, Habiganj.	Ditto	Deep water paddy.
	Fruit Experimental Station, Shillong	63	Fruit Inspector	Director of Agriculture, Assam	Fruit culture.
North-West Frontier Province	Tarnab Agricultural Research Station	200	Farm Manager	Extra Assistant Director of Agriculture, Northern Circle.	
	Haripur (Hazara) Agricultural Farm	16	Agricultural Assistant	Ditto.	
	Serai Naurang Farm (Bannu)	100	Farm Manager	Extra Assistant Director of Agriculture, Southern Circle	
	Noel Garden (Dera Ismail Khan)	13	Agricultural Assistant	Ditto.	
	Alizai and Parachinar (Kurram Agency)	50	Ditto	Ditto.	

List of Agricultural Stations in India in 1935-36—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising officer	Remarks
Sind	Government Fruit Farm, Mirpurkhas	60	Horticulturist	Director of Agriculture.	
	Fruit Sub-station, Larkana	60	Manager, Fruit Sub-station	Ditto.	
	Jamesabad Sub-station	29	District Agricultural Overseer, Jamrao.	Inspector of Agriculture, Jamrao Division, Mirpurkhas.	
	Nawabshah Sub-station	16	Inspector of Agriculture, Nawabshah.	Inspector of Agriculture, Nawabshah.	
	Government Auxiliary Farm, Oderolal	362	Manager, Government Auxiliary Farm, Oderolal.	Director of Agriculture.	
	Government Auxiliary Farm, Lundo	457	Manager, Government Auxiliary Farm, Lundo.	Ditto.	
	Government Auxiliary Farm, Pad Idan	292	Manager, Government Auxiliary Farm, Pad Idan.	Ditto.	
	Government Auxiliary Farm, Dadu	585	Manager, Government Auxiliary Farm, Dadu.	Ditto	
	Government Auxiliary Farm, Shahdadkote.	180	Manager, Government Auxiliary Farm, Shahdadkote.	Ditto.	
	Government Auxiliary Farm, Nasirabad	311	Manager, Government Auxiliary Farm, Nasirabad.	Ditto.	
	Rice Research Station, Larkana	54	Superintendent	Botanist.	
	Agricultural Sub-Station, Gujo, Taluka Mirpur Sakro.	59	Inspector of Agriculture, Tatta.	Inspector of Agriculture, Tatta	Station opened for two years for experimental purpose and worked on *hari* system.
	Agricultural Research Station, Sakrand	234	Officer in charge, Agricultural Research Station, Sakrand.	Director of Agriculture.	
	Government Seed Farm, Mirpurkhas	200	Cotton Breeder and Officer in charge, Seed Farm, Mirpurkhas.	Ditto.	

British Baluchistan . .	*Fruit Experiment Station, Quetta* .	25	*Assistant Pomologist* .	Agricultural Officer in Baluchistan.	
	Seed Farm, Usta, Sibi District . .	300	Agricultural Assistant .	Ditto.	
Hyderabad . . .	Main Experimental Farm, Himayatsagar.	299	Farm Superintendent .	Deputy Director of Agriculture, West Telingana.	
	Main Experimental Farm, Warangal .	104	Ditto . . .	Deputy Director of Agriculture, East Telingana.	
	Main Experimental Farm, Raichur .	116	Ditto . . .	Deputy Director of Agriculture, Karnatik.	
	Main Experimental Farm, Parbhani .	265	Ditto . . .	Deputy Director of Agriculture, Godavari.	
	Experimental Farm, Sangareddi .	78	Ditto . . .	Deputy Director of Agriculture, West Telingana.	
	Experimental Farm, Rudrur . .	65	Ditto . .	Ditto.	
	Demonstration Farm, Mahbubnagar .	76	Ditto . . .	Ditto.	
	Cattle Breeding Farm, Himayatsagar	464	Ditto . . .	Director of Agriculture.	
	Poultry Farm, Himayatsagar . .	Suitable plot reserved on the Main Farm, Himayat sagar.	Fieldman . . .	Deputy Director of Agriculture, West Telingana.	
Mysore	Irwin Canal Farm, Mandya . .	650	Superintendent . .	Director of Agriculture, Bangalore.	
	Government Experimental Farm, Marthur, Talaguppa P. O.	116	Manager	Senior Assistant Director of Agriculture, Shimoga.	
	Government Experimental Farm, Babboor, Hiriyur.	220	Farm Manager . .	Director of Agriculture . .	Breeding work on cotton is being done by Senior Assistant Botanist.
	Jeevanarayankatte Demonstration Plot, Mysore.	2	Agricultural Inspector .	Assistant Director, Mysore.	
	Government Coffee Experimental Station, Balehonnur.	290	Farm Manager . .	Senior Assistant Director, Chikmagalur.	

List of Agricultural Stations in India in 1935-36—contd.

Province or State	Agricultural Station	Area in acres	Officer in immediate charge	Supervising Officer	Remarks
Mysore	District Board Agricultural School Farm, Hassan.	10	Head Master	President, District Board, Hassan.	
	Cattle Breeding Station, Ajjampur	6,020	Mr. C. Narasinga Raju, L.Ag.	Live-Stock Expert, Bangalore.	
	Cattle Breeding Sub-Station, Basur		Mr. S. K. Venkata Rao.	Ditto.	
	Sheep Farm, Ajjampur		Mr. C. Madanagopal, L.Ag.	Ditto.	
	Sheep Farm, Yellachihalli, Yelwal Post	500	Mr. M. Krishna Sastri, B.A., I.D.D.	Ditto.	
	Dairy and Sheep Farm, Hebbal, Bangalore.	5	Mr. Arcot Devaraj, B.Ag.	Ditto.	
	S. K. V. D. Patasala	40	Head Master	Assistant Director, Tumkur.	
	Paddy Breeding Station, Naganahalli	63	Junior Assistant Botanist	Deputy Director of Agriculture, Bangalore.	
	Kar Ragi Breeding Station, Hunsur	44	Ditto	Ditto.	
	Rama Krishna Krishi Sala	210	Head Master	Assistant Director, Mysore.	
Baroda State	Baroda Agricultural Experimental Station.	84	Mr. R. S. Patil	Commissioner of Agriculture.	
	Jagudan	38	Mr. R. G. Patel	Ditto.	
	Amreli	56	Mr. D. G. Kelkar	Ditto.	
	Vyara Sugarcane Investigation Station	16	Mr. G. G. Navathe	Ditto.	
Travancore	Paddy Farm, Nagercoil	40	Agricultural Inspector	Director of Agriculture and Fisheries.	
	Fruit Farm, Cape Comorin	16	Agricultural Sub-Inspector	Ditto.	
	Agricultural School Farm, Kottarakara.	200	Headmaster	Ditto.	
	Pepper Farm, Koni	150	Agricultural Inspector	Agricultural Inspector, Kottarakara.	

	Demonstration Farm, Pullyara	35	Ditto	Ditto.	
	Coconut Farm, Cachira	4	Agricultural Demonstrator, Kayamkulam.	Agricultural Inspector, Mavelikara.	
	Coconut Experimental Farm, Alleppey	9	Agricultural Demonstrator, Alleppey.	Agricultural Inspector, Vaikom.	
	Demonstration Farm, Alwaye	13	Agricultural Sub-Inspector, Alwaye.	Director of Agriculture and Fisheries.	
	Government Central Farm, Ollukara, Trichur.	405	Manager, Government Central Farm.	Director of Agriculture, Cochin State.	
Cochin	Government Coconut Experimental Station, Vaittila, Ernaculam.	25	Agricultural Inspector, Cochin-Kanayannur Taluk.	Ditto.	
	Farm, Nabi Bagh	154	Mr. V. N. Varma, L.Ag.	Director of Agriculture, Bhopal.	
Bhopal	Semri Demonstration Farm	100	Mr. B. V. Shirali, B.Ag.	Ditto.	
	Sehore Sugarcane Farm	10	G. M. Rao, L.Ag.	Ditto.	
	Pratap Model Farm	75	Manager	Director of Agriculture.	
Jammu and Kashmir	Gobamander Farm	28	Inspector	Ditto.	

APPENDIX III

Staffs of Provincial and State Departments of Agriculture in India during 1935-36

Province or State	RESEARCH AND TEACHING STAFF						DISTRICT STAFF					
	SUPERIOR SERVICE		PROVINCIAL SERVICE		SUBORDINATE SERVICE		SUPERIOR SERVICE		PROVINCIAL SERVICE		SUBORDINATE SERVICE	
	Sanctioned cadre.	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled Substantively	Sanctioned cadre	Filled substantively	Sanctioned cadre	Filled substantively
British India												
Madras	4	3	23	21	109	108	7	7	14	14	264	256
Bombay (proper)	2	2	17	17	106	106	3	3	8	8	110	110
Bengal	3	1	7	7	33	33	2	2	..	6	146	146
United Provinces	7	6	9	8	70	70	13	11	15	9	315	315
Punjab	13	12	26	26	125	125	10	9	19	19	370	370
Burma	9	9	25	25	100	82	..	..	..	..	..	..
Bihar and Orissa	..	..	11	8	3	2	2	2	24	16	124	112
Central Provinces	2	2	7	6	20	20	4	4	14	9	120	120
Assam	1	1	2	2	15	15	..	..	5	5	24	24
North-West Frontier Province	1	1	2	2	19	19	..	..	2	2	6	6
Sind	2	2	5	5	17	17	..	..	3	3	103	103
Baluchistan	*Nil*	..	*Nil*	..	..	2*	1	1	..	..	..	..
Indian States												
Hyderabad	2	2	4	3	9	9	5	5	6	6	54	46
Baroda	1	1	3	3	2	2	4	3	8	8	11	7
Travancore	5	7	..	..	2	2	11	11	6	6	8	8
Cochin	4	4	..	..	16	16	8	8	..	..	6	6
Bhopal	3	1	5	5	9	9	1	1	4	4	20	16

* Excludes eight temporary staffs.

APPENDIX IV

Showing results of well-boring in India during 1934-35 and 1935-36

Province or State	1934-35		1935-36	
	Number of bores	Number successful	Number of bores	Number successful
(a) British India				
Madras	1,175	769	995	671
Bengal	191	180	206	196
United Provinces	1,824	1,433	2,126	1,736
Punjab	276	230	420	343
Bihar and Orissa	296	227	260	207
North-West Frontier Province	2	2	..	..
Sind	3	3	..	..
TOTAL	3,767	2,853	4,007	3,153
(b) Indian States				
Hyderabad	45	45	35	29
Mysore	32*	20*	18	15
Baroda — Bores	53	33	55	42
Baroda — Blasting	103	81	33	24

* Revised figures.

APPENDIX V

Showing sale of improved implements through departmental agency in India during 1934-35 and 1935-36

Province or State	Ploughs		Cane-Mills		Fodder-Cutters		Hoes		Other implements		Spare parts	
	1934-35	1935-36	1934-35	1935-36	1934-35	1935-36	1934-35	1935-36	1934-35	1935-36	1934-35	1935-36
(a) British India												
Madras	2,945	3,066	62	346	2	12	66	68	689	942	2,639	4,277
Bombay	687	573	85	222	1	5	19	76	2,580	3,160	1,099	1,605
Bengal	40	26	12	24	1	..	1	9	6	8	5	2
United Provinces	4,531	6,479	597	348	1,671	3,575	274	860	786	1,030	10,188	16,499
Punjab	3,515	5,892	3,202	2,081	26,070	28,768	221	596	1,422	3,406	5,678	7,985
Burma	4,877	8,405	29	10	*Nil*	*Nil*	27	650	711	895	268	133
Bihar and Orissa	478	559	8	18	441	..	417	428	319	265	1,236	1,281
Central Provinces	2,939	2,262	184	178	6	20	400	681	2,499	1,688	29,631	21,216
Assam	*Nil*	3	90	72	*Nil*	*Nil*	*Nil*	*Nil*	27	74	133	108
North-West Frontier Province	56*	74	8	315	56*	5	..	21	..	94	29*	138
Sind	346*	1,316	..	..	..	..	12*	..	166*	352	6*	..
TOTAL	20,414*	28,655	4,277	3,614	28,248*	32,385	1,487*	3,389	9,205*	11,914	50,912*	53,244
(b) Indian States												
Hyderabad	559	665	48	53	46	29	350	89	478	320	48	..
Mysore	2,078	825	126	71	..	..	836	62	200	194	5,602	5,815
Baroda	52	40	..	..	..	..	..	..	..	1	..	..
Travancore	..	..	..	..	..	..	..	..	25	62	..	..
Cochin	..	14	..	..	..	..	..	..	46*	99	..	..
Bhopal	5	..	..	..	..	..	10	15	25	..	..	50
Jammu and Kashmir	Spraying machinery.								12 Bucket pumps of local design.			

* Revised figures.

APPENDIX VI

Improved seeds and manures distributed through departmental agency in India during 1934-35 and 1935-36

Province or State	SEED DISTRIBUTED						MANURES DISTRIBUTED			
	SEED GRAIN IN CWT.		NO. OF WHOLE CANES EXCEPT WHERE OTHERWISE STATED		FRUIT PLANTS NO.		COMMERCIAL FERTILIZERS IN CWT.		OIL-CAKES IN CWT.	
	1934-35	1935-36	1934-35	1935-36	1934-35	1935-36	1934-35	1935-36	1934-35	1935-36
(a) British India										
Madras	11,563†	18,755	144,762	340,582	162,460	106,554	151	805	274	8
Bombay	29,303	38,714	509,043 63,000*	1,920,442	87,917	108,400	14,364	26,139	9,087	7,206
Bengal	6,008	6,926	12,683,440*	19,072,000*	1,475	515	343	2,152	266	167
United Provinces	186,739	187,222	1,657,744	2,652,111	10,126	11,768	44,037	79,415	21,748	16,982
Punjab	122,122†	167,289	(a)	(a)	..	..	(b)	(b)	..	..
Burma	138,712	106,699	1,260,810	1,478,300	2,395	12,689	3,477	3,760	..	..
Bihar and Orissa	4,728	2,607	70,923	296,063 *plus* 16,447 cwts.	3,061	3,155	21,062	45,037	..	60
Central Provinces	241,587	269,741	2,298,933	3,705,066	(c)30,629	(d)65,303	2,757	9,300	..	577
Assam	1,606	2,105	116,355*	303,761*	2,018	34,711	9	127	56	78
North-West Frontier Province	34†	22	139,285 lbs.	98,400 lbs.	14,943†	20,020	..	157	..	..
Sind	26,526†	78,659	150†	713	31,479†	33,084	..	1	..	..
Baluchistan	..	478	*Nil*	*Nil*	4,872	1,578	*Nil*	..	*Nil*	*Nil*
(b) Indian States										
Hyderabad	8,432	5,087	4,492 cwts.	11,787 cwts. seed.	12,991	1,607	281	5,500	1,541	10,349
Mysore	4,753	15,703	20,427,336*	28,587,910*	6,143	6,395	94,732	66,936	4,095	11,275
Baroda	379	9,507	3,103†	5,339	2,421	2,576	..	55	..	..
Travancore	380	167	18,100*	19,200*	1,208	1,231	(e)	..	..	..
Cochin	138	140	4,252 8,966*	700 12,166*	1,630	3,147	186	641	294	554
Bhopal	135	522	13,830	1,600	..	200	8	10	..	3
Jammu and Kashmir	903	..	(f)	..	180,306	177,719	3	5	..	..

(a) The Dept. does not stock sugarcane seed for sale apart from such areas as are available from its seed farms.
(b) Artificial manures are supplied to zemindars directly by manufacturers and no record of their sale is available with the Department of Agriculture, Punjab.
(c) Figures for Southern and Western circles not available. (d) Figures for Southern circle not available.
(e) No direct sales by the Department. (f) Quantity sufficient to cover an area of 25 acres.
* Setts.
† Revised figures.

APPENDIX VII

Demonstration and propaganda work in India during 1934-35 and 1935-36

Province or State	Number of Agricultural Shows Held		Number of Practical Demonstrations Carried Out		Number of Illustrated Lectures Given	
	1934-35	1935-36	1934-35	1935-36	1934-35	1935-36
British India						
Madras	278	369	19,042	21,089	450	455
Bombay	61	76	1,754	2,300	471	605
Bengal	53	71	3,510	4,569	608	220
United Provinces	111	162	10,376	12,642	1,470‡	5,317
Punjab	299	365	9,109	12,327	873	1,224
Burma	3	5	2,043	3,201	216	160
Bihar and Orissa	21	22	14,572	13,909	37	65
Central Provinces	64	107	6,234	8,053	482	623
Assam	6	19	3,258	2,170	..	46
North-West Frontier Province	8‡	4	608‡	1,681	7	127
Sind	19‡	42	656	814	32‡	66
Baluchistan	..	1	(*a*)	(*b*)	..	..
Indian States						
Hyderabad	170	50	1,911	452	134	167
Mysore	51	221	1,648	2,404	158	534
Baroda	2	2	9	3	..	(*c*)
Travancore	4	5	201	203	41	42
Cochin	5	4	287	271	2	18
Bhopal	1	6	44	57	..	15
Jammu and Kashmir	1	1	(*d*) 200* 18†	(*e*) 209* 12†	62	..

(*a*) 13,074 fruit trees sprayed. 3,000 holes were treated with cyanogas to kill rats.
(*b*) 773 fruit trees sprayed. 500 holes were treated with cyanogas to kill rats.
(*c*) The work of propaganda is handed for the present by the visual instruction branch independent of this Department. Next year onwards the Baroda Agricultural Department will start giving a series of illustrated lectures in the villages of four districts for popularising improved agriculture.
(*d*) 307,344 trees sprayed at owners' cost in different tehsils.
(*e*) 529,129 fruit plants and 6,758 roses were sprayed.
* Practical demonstration on pruning, planting and budding.
† Manurial demonstrations on Government cost.
‡ Revised figures.

APPENDIX VIII

Agricultural Colleges and Schools in India during 1935-36

Name of College or School	Course of instruction	1934-35				1935-36			
		Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination
(a) BRITISH INDIA									
(i) Post-graduate Training Institutes									
Imperial Agricultural Research Institute, New Delhi.	Two-year Post-graduate course.	32	10	(a)27	10	33	10	(a)25	7
	One-year Post-graduate course in Farm Management.		3	4	1		3	6	3
	Special course . . .	..	11	11	11	..	4	4	4
Imperial Dairy Department, Bangalore—									
Post-graduate course . .	15 months	4	2	3	3	..	2	1	1
Indian Dairy Diploma . .	2 years	*	..	21	..	65	24	23	17
Short Courses, Practical .	....	4	4	4	2	10	8	10	8
Short Courses									
Post-graduate character. .	....	2	2	2	2	†	..	..	..
Vocational training of British soldiers.	6 months	12	12	12	15	25	25	25	13

(a) One left without completing the course.
* No admission made during 1934-35 being an intermediate year and as students are taken once in two years.
† Discontinued from 1935-36.

Agricultural Colleges and Schools in India during 1935-36—contd.

Name of College or School	Course of Instruction	1934-35				1935-36			
		Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination
(ii) Agricultural Colleges									
Agricultural College, Coimbatore	B.Sc.Ag. Degree Course of the Madras University.	91	28	104	31	116	46	110	28
Agricultural College, Poona .	Three-year Degree Course .	103*	80	169	42	114	81‡	170	43
Agricultural College, Cawnpore .	B. Sc., Agric., Agra University and Inter-Agricultural Board of High School and Intermediate Examination.	129	54	151	65	129	54	160	74
Allahabad Agricultural Institute	Indian Dairy Diploma Course	10	9	16	5	..	..	8	..
	Intermediate in Agriculture	50	34	67	27	45	31	62	28
	B. Sc. in Agriculture . .	16	16	35	19	27	21	37	16
Punjab Agricultural College, Lyallpur.	4-year B. Sc. (Agri.) Degree Course.	137§	82	145	16‖	180§	68	186	15¶
	1½-year M. Sc. Degree Course	8	5	9	2	3	1	4	..
	2-year Leaving Certificate Course.	..	..	17	14	..	..	9	8
	6-month Summer Vernacular Course at Lyallpur.	**	48	34	26	**	42	39	35
	6-month Summer Vernacular Course at Gurdaspur.	..	..	..	..	43	20	20	17
	6-month Winter Vernacular Course at Lyallpur.	**	50	44	35	**	30	28	25**
	6-month Winter Vernacular Course at Gurdaspur.	..	..	..	..	57	42	38	37
	10-month Teachers' Training Course.	37	14	14	13††	122	30	30	30

	6-month Vernacular Course in Dairying.	43	14	9	8††	20	11	11	10
	6-month Course in Lohar Class.	27	27	19	17	30	30	14	12
	Two Weeks' Summer Course in Fruit and vegetable preservation.	108	51	29	29	131	42	32	32
	Two Weeks' Fruit Culture Course.	31	31	12	12	57	32	29	24
	Two Weeks' Winter Fruit Preservation Course.	24	24	13	13	38	29	16	16
	6-months' Post-graduate Course in Sugar-Chemistry.	24	6	4	4	The course was not held this year.			
Agricultural College, Mandalay, Burma.	....	..	..	..	..	..	..	..	..
Agricultural College, Nagpur .	Four-Year Degree Course .	74	44	130	26	89	48	135	20
Islamia Agricultural College, N.W. F. Province.	I year	15	15	15	12	17	17	17	15
	II year	12	12	9	5	12	12	10	5
	III Year	..	..	..	..	6	6	5	2‡‡
	IV Year	..	..	..	..	..	..	..	..

(iii) Agricultural Schools

Madras.									
School for Juveniles at Coimbatore.	3 Rs. I and II standards in Tamil, Arithmetic, Geography and Agriculture.	..	7	21	8	..	24	19	9
School for Juveniles at Palur near Nellikuppam.	3 Rs. I to V standards in Tamil	16	16	30	6	5	5	29	1
School for Juveniles at Anakapalle.	3 Rs. I to V standards in Telugu.	15	6	26	19	50	9	24	17

‡ 101 admitted but only 81 finally remained on the roll.
§ Total No. of applications received for admission to Leaving Certificate and Degree Courses.
‖ 12 students under Compartment excluded.
¶ 9 students under Compartment excluded.
** Applications for admission were received by respective Deputy Directors of Agriculture.
†† 1 under Compartment excluded.
‡‡ 3 students in Compartment examination.
* Revised figure.

Agricultural Colleges and Schools in India during 1935-36—contd.

Name of College or School	Course of instruction	1934-35				1935-36			
		Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination	Applications for admission	Admissions made during the year	Total number on the roll	Number passed in final examination
Bombay									
Vernacular Agricultural School, Dhulia.	2-year course . . .	16	16	25	9	60	17	32	14
Vernacular Agricultural School, Devihosur.	2-year course . . .	80	17	30	13	37	15	32	16
Bengal									
Dacca Secondary Agricultural School.	2 years	226	17	32	13	429	20	36	13
United Provinces									
Bulandshahr School . .	2-year Diploma course .	37	25	49	24	25	25	25	25
	6-month Fieldman Class .	8	8	8	8	6	6	6	6
	6-month Farm Mechanic Class	9	8	8	8	18	8	8	8
Gorakhpur School . . .	2-year course . . .	34	22	20	20	66	27	25	20
Burma									
1. Pyinmana Agricultural School	4-year course . . .	..	38	74	12	..	34	72	12
2. Farm Schools—									
(*a*) Hmawbi . . .	Nine-month course .	..	8	8	8	..	10	8	7
(*b*) Mahlaing . . .		..	4	13	12	..	4	13	13
3. Training of adult Cultivators	Short courses . . .	..	36	36	35	..	33	33	32
Central Provinces									
Agricultural Anglo-vernacular Middle School, Powarkhera, Hoshangabad.	4-year course . . .	30	26	85	14	18	18	68	9

(b) INDIAN STATES

Hyderabad											
Oil-Engine Class, Machinery Section.	3-months	..	..	24	22	31	26	24	20
Gardeners' Class, Himayatsagar Main Farm.	2-years	..	..	10	..	15	7	10	2
Farmers' Class, Himayatsagar Main Farm.	2-years	..	..	..	..	41	12	11	..
Farmers' Class, Parbhani Main Farm.	2-years	..	..	..	..	28	12	11	..
Mysore									
Agricultural School, Hebbal .	3-years	62	30	87	16	54	37	92	31
Ramakrishna Krishisala, Ramakrishnapur.	1-year	85	11	11	11	73	15	15	14
S. K. V. D. Patasala Chikkanhalli, Sira Taluk.	1-year	62	15	15	14	57	18	18	16
Agricultural School, Hassan .	1-year	21	21	21	16	74	20	18	10
Baroda									
Baroda State Agricultural School	The Courses are possibly all practical and they are as below: (1) Agricultural (2) Horticultural (3) Poultry (4) Animal Husbandry (5) Health and Sanitation (6) Co-operation (7) Secondary occupations like carpentry, smithy, engineering classes.	90	25*	21	21	81	25	23	23
Travancore									
Agricultural School, Kotharakara	2-years	80	21	19	No examination	50	20	18	13
Agricultural School, Koni . .	2-years	..	..	28	14	..	30	24	No. examination
Cochin									
Agricultural School, Central Farm	1-year	17	17	16	15	†	†	†	†
Horticultural Schools, Central Farm, Ollukara, Trichur and Trippunthurah.	2-years	60	60	120	52	60	60	120	45

* The students were getting stipend of Rs. 15 p. m. each from the Baroda Government and hence the admission is restricted. The course is a one-year Certificate Course.
† School did not work.

APPENDIX IX

Operations of Non-credit Agricultural Co-operative Societies in India during 1935-36

(A) Purchase, Sale and Production

Province or State	Class of Societies	Number of Societies	Number of Members	Sale of goods to Members	Purchase of members' products	Working Capital	Profit (+) and loss (—) for the year
				Rs.	Rs.	Rs.	Rs.
Madras	Purchase and purchase and sale.	91	13,855	1,82,761	1,85,216	10,71,671	+7,974
	Production and sale	13	1,108	70,517	66,277	1,31,743	—10,824
	Others	339	21,874	11,143	1,335	27,32,685	—48,180
	Total	443	36,837	2,64,421	2,52,828	39,36,099	—51,030
Bombay	Purchase and purchase and sale.	56	6,903	33,492	1,72,274	2,60,299	+9,994
	Production	17	613	..	..	9,112	—176
	Production and sale	77	18,889	22,197	38,709	15,47,337	+48,375
	Total	150	26,405	55,689	2,10,983	18,16,748	+58,193

Bengal	Purchase and purchase and sale.	73	13,510	2,22,398	1,33,254	7,80,289	+6,039
	Production	957	21,869	187	15,627	4,88,954	—7,454
	Production and sale	246	13,768	1,90,822	3,51,629	9,01,659	+69,601
	TOTAL	1,276	49,147	4,13,407	5,00,510	21,70,902	+68,186
United Provinces	Purchase and sale	1	48	..	..	1,322	—47
	Production and sale	411	25,608	4,95,513	6,62,099	3,24,200	+20,892
	TOTAL	412	25,656	4,95,513	6,62,099	3,25,522	+20,845
Punjab	Purchase and purchase and sale.	18	1,467	89,882	72,574	80,771	—355
	Production	217	5,138	85	90	6,795	+417
	Production and sale	1,398	112,453	10,01,569	10,01,504	5,86,805	+6,399
	Others	94	2,012	20	..	99,565	+3,694
	TOTAL	1,727	121,070	10,91,556	10,74,168	7,73,936	+10,155

Operations of Non-credit Agricultural Co-operative Societies in India during 1935-36—contd.

(A) PURCHASE, SALE AND PRODUCTION—*contd.*

Province or State	Class of Societies	Number of Societies	Number of Members	Sale of goods to Members	Purchase of members' products	Working Capital	Profit (+) and loss (—) for the year
				Rs.	Rs.	Rs.	Rs.
Burma	Purchase and purchase and sale.	1	300	15	..	31,094	+20
	Production	5	50	..	..	..	..
	Production and sale	10	1,222	3,208	..	1,08,976	—47,706
	TOTAL	16	1,572	3,223	..	1,40,070	—47,686
Bihar	Purchase and purchase and sale—						
	(*a*) Agricultural sale	1	162	..	..	2,602	—218
	(*b*) Better Farming	2	37	..	..	8	+14
	Production (Irrigation)	1	100	..	..	6,548	..
	Production and sale—						
	Sugarcane-growers	6	73	..	..	1,721	—54
	Dairy.	1	43	..	..	4,258	+41
	Other forms (Village welfare)	13	520	..	..	1,431	+448
	TOTAL	24	935	..	..	16,568	+231

Central Provinces	Purchase and sale	44	1,868	84,569	47,667	3,21,227	11,120
	Production	14	372	323	..	6,273	838
	Production and sale	9	832	4	..	24,103	771
	TOTAL	67	3,072	84,896	47,667	3,51,603	12,729
Assam	Production and sale	1	50	2,303	2,442	811	—152
	Purchase and sale, Limited	7	147	1,061	930	6,969	+93
	Purchase and sale, un-limited	18	302	9,557	9,003	5,973	+377
	TOTAL	26	499	12,921	12,375	13,753	+318
North-West Frontier Province	Production and sale	20	5,751	1,439	531	89	+24
	TOTAL	20	5,751	1,439	531	89	+24
Delhi	Production and sale	13	872	..	..	355	+23
	TOTAL	13	872	..	..	355	+23

Operations of Non-credit Agricultural Co-operative Societies in India during 1935-36—contd.

(A) PURCHASE, SALE AND PRODUCTION—*concld.*

Province or State	Class of Societies	Number of Societies	Number of Members	Sale of goods to Members	Purchase of members' products	Working Capital	Profit (+) and loss (—) for the year
				Rs.	Rs.	Rs.	Rs.
Hyderabad	Cotton Sale Limited and other sale product societies.	16	1,307	2,10,908	2,12,386	1,26,689	+6,258
	TOTAL	16	1,307	2,10,908	2,12,386	1,26,689	+6,258
Mysore	Purchase and purchase and sale.	23	637	118	..	71,232	+37
	Production and sale	17	475	520	416	14,531	+322
	Others	41	1,299	..	..	11,651	+363
	TOTAL	81	2,411	638	416	97,414	+722
Baroda	Purchase and sale	10	406	51	..	3,241	+24
	Production	27	1,181	1,536	3,175	1,06,711	+5,800
	Production and sale	20	1,161	5,41,724	4,75,893	56,279	+1,011
	TOTAL	57	2,748	5,43,311	4,79,068	1,66,231	+7,835

Travancore	*Production and sale* . .	1	70	3,440	2,960	955	+710
	TOTAL .	1	70	3,440	2,960	955	+710
Cochin	Purchase and sale . . .	12	772	75,849	*Nil*	24,115	+283
	Production	3	136	1,626	..	3,450	—42
	TOTAL .	15	908	77,475	*Nil*	27,565	+241

(B) CATTLE INSURANCE

Province or State	Number of Societies	Amount of risk insured	Premia collected during the year	Supplementary contributions collected	Number of Animals		Claims paid	Cost of management	Funds in hand at the end of the year	Amount of risk re-insured	Amount of premia paid for re-insurance
					Insured	Lost					
		Rs.	Rs.	Rs.			Rs.	Rs.	Rs.	Rs.	Rs.
Bombay Presidency .	1	8,065	403	..	142	14	497	473	725	3,380	169
Burma . . .	239	1,970	87	..	67	3	113	26	17,493	1,403	43

APPENDIX X

Showing the working of the Veterinary Departments in India during 1935-36

Province or State	1935-36											
	Reported mortality from Contagious Diseases			Dispensaries and Hospitals			District work					
	Rinderpest	Other Diseases	Total	Number of Institutions	Cases treated	Castrations performed	Cases treated	Castrations performed	Outbreaks in which inoculation was undertaken	Deaths un-inoculated	Inoculations	Deaths after inoculation
Madras	2,752	20,533	23,285	113	247,762	24,068	115,316	46,508	1,239	10,362	374,077	297
Bombay	11,993	11,882	23,875	112	220,845	31,948	55,713	10,105	1,229	12,480	136,686	242
Bengal	35,281	7,959	43,240	54	166,357	823	232,207	5,045	1,759	29,505	396,835	6,925
United Provinces	18,517	10,815	29,332	180	504,391	77,249	170,451	15,111	1,766	16,455	275,107	195
Punjab	8,747	20,725	29,472	300	1,768,383	330,193	488,630	246,140	3,507	10,493	652,613	654
Burma	28,509	10,377	38,886	1	1,892	13	30,525	22	521	13,379	116,933	1,480
Bihar and Orissa	6,427	5,061	11,488	129	99,326	21,743	324,393	108,618	649	3,167	576,011	240
Central Provinces and Berar	9,520	9,489	19,009	104	223,641	20,586	619,309	151,073	1,988	10,015	475,438	35
Assam	15,086	8,727	23,813	3	5,862	399	112,680	25,334	357	8,828	97,751	466
North-West Frontier Province	347	1,366	1,713	53	171,678	30,825	64,528	20,519	57	500	31,857	8
Sind	1,033	4,557	5,590	19	31,825	2,326	9,780	1,202	52	428	3,805	32
Baluchistan	..	159	159	10	34,777	269	59,595	13	..	328	1,012	2
TOTAL	138,212	111,650	249,862	1,078	3,476,739	540,442	2,283,127	629,690	13,124	115,940	3,138,125	10,576
Ajmer-Merwara	694	596	1,290	3	7,343	460	1,519	77	10	82	519	2
Coorg	468	900	1,368	5	53,276	386	2,181	1,030	109	283	3,798	6
Hyderabad	7,068	6,349	13,417	102	268,163	..	53,144	28,874	564	6,646	271,897	69
Mysore	53	11,514	11,567	68	522,295	23,222	106,106	58,264	..	..	143,362	..
Bhopal	*	*	*	5	29,478	2,662	15,973	2,333	49	..	1,925	..
TOTAL	8,283	19,359	27,642	183	880,555	26,730	178,923	90,578	732	7,011	421,501	77
GRAND TOTAL	146,495	131,009	277,504	1,261	4,357,294	567,172	2,462,050	720,268	13,856	122,951	3,559,626	10,653

* No record is kept.

APPENDIX XI

Showing the working of the Veterinary Colleges and Schools in India during 1935-36

Veterinary College or School	Length of Course	NUMBER OF STUDENTS						EDUCATIONAL QUALIFICATIONS OF STUDENTS ADMITTED		
		ADMITTED DURING THE YEAR		Passed final examination	Failed in final examination	UNDER INSTRUCTION AT END OF YEAR		Intermediate and above	Matriculate or S. L. C.	Lower qualifications
		Scholarship-holders	Others			Ordinary course	Failed students			
Madras Veterinary College	3 years	4	27	24	7	62	34	11	20	..
Bombay Veterinary College	3 years	15	27	15	12	79	24	9	33	..
Bengal Veterinary College	3 years	10	57	42	14	90	42	5	49	13
Punjab Veterinary College	4 years	7	49	21	1	65	20	43	13	..
Bihar and Orissa Veterinary College	3 years	10	26	9	..	38(*b*)	17	2	34	..
Insein Veterinary School	1 year (Vernacular).	5(*a*)	11(*a*)	11	2	..	..	..	5	11
		7(*c*)	12(*c*)	..	..	14(*c*)	..	..	5	14

(*a*) Enrolled in January 1935. Of the 16 students admitted, 3 resigned during the year.
(*b*) Includes 4 students debarred from appearing at the examination on account of shortage in the percentage of attendance and one expelled from the examination hall.
(*c*) Enrolled in November 1935. Of the 19 students admitted, 1 was declared medically unfit and 4 were removed during the year.

APPENDIX XII

Showing the number of cattle issued from Government Farms during 1935-36

Province or State	Bulls	Cows	Male buffaloes	She buffaloes	Young stock	Total for 1935-36	Total for 1934-35
		Imperial					
Pusa	1	17	..	..	22	40	60
Karnal	..	14	1	..	48	63	81
Imperial Dairy Institute, Bangalore	1	35	..	2	80	118	86
Milk Depot, Wellington*	..	..	..	..	..	..	..
		Provincial					
Madras	55	43	..	1	17	116	94†
Bombay	37	20	3	6	25	91	71
Bengal	36	15	..	1	7	59	41†
United Provinces	345	..	109	..	..	454	325
Punjab	616	222	..	..	108	946	770
Burma	26	54	..	..	49	129	75
Bihar and Orissa	5	12	26	12	52	107	107†
Central Provinces and Berar	24	53	6	17	69	169	266
Assam	53	27	..	..	17	97	81†
Sind	1	2	2	..	8	13	14†
		Indian States					
Mysore	24	10	..	..	56	90	102
Cochin	..	..	..	..	11	11	16
Baroda	..	1	..	2	9	12	8

* This Depot has no milk cattle of its own as animals in milk are transferred to Wellington and returned to Bangalore when dry.

† Revised figures.

APPENDIX XIII

List of Agricultural and Animal Husbandry Publications in India published during 1935-36

Title	Author	Where published
GENERAL AGRICULTURE		
Agriculture and Live-stock in India, Vol. V, Parts 5 and 6 and Vol. VI, Parts 2 to 4. Annual subscription Rs. 6 or 9*s.* 9*d.* (A bi-monthly journal of agriculture and animal husbandry for the general reader interested in agriculture or live-stock in India or the Tropics).	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.
The Madras Agricultural Journal. Monthly. Annual subscription Rs. 4.	Published by the M. A. S. Union, Agricultural Research Institute, Coimbatore.	The Secretary, M. A. S. Union, Agricultural College, Lawley Road P. O.
The Journal of the Trichinopoly District Agricultural Association (English and Tamil). Quarterly. Annual subscription Re. 1-8-0 for non-members, free for members.	Issued by the Trichinopoly District Agricultural Association, Teppakulam Post.	The Secretary, the Trichinopoly District Agricultural Association, Teppakulam Post.
The Journal of the Mysore Agricultural and Experimental Union (English). Quarterly. Price As. 12 per copy.	B. Narasimha Iyengar (Chief Editor).	The Secretary, the Mysore Agricultural and Experimental Union, Seshadri Road, Bangalore.
The Journal of the Mysore Agricultural and Experimental Union (Kannada). Monthly. Price As. 4 per copy.	K. Bhima Rao (Editor) .	Ditto.
The Poona Agricultural College Magazine. Quarterly. Annual subscription Rs. 2-8-0.	V. G. Deshpande and S. M. Rao (Editors).	The Editor, *Poona Agricultural College Magazine*, Poona.
Shetki Shetkari (Marathi). Monthly. Annual subscription Re. 1-3-0.	Vasudev Ganesh Pande .	The Editor, *Shetki Shetkari*, Agricultural College, Poona.
The Planters' Journal and Agriculturist. Fortnightly. Annual subscription Rs. 10 or 16*s.*	Theo. H. Thorne (Editor)	The Manager, the Planters' Journal and Agriculturist, 13, Ezra Mansions, Calcutta.
Krishi-Sampad (Bengali). Monthly. Annual subscription Rs. 3.	N. K. Ghosh (Editor) .	The Manager, Krishi Sampad Office, Dacca.
Mufidul Mazarin (Urdu) . . .	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, United Provinces, Allahabad.
Kisan Upkarak (Hindi) . . .	Ditto .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
The Allahabad Farmer. Bi-monthly. Annual subscription in India Rs. 2.	B. M. Pugh (Editor). Published by the Agricultural Institute, Allahabad.	The Allahabad Agricultural Institute, United Provinces (American Presbyterian Mission), Allahabad.
Seasonal Notes. Price As. 4 per copy.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
The Nagpur Agricultural College Magazine. Quarterly. Annual subscription Rs. 3.	Published by P. D. Nair, Agricultural College, Nagpur.	The Editor, the *Nagpur Agricultural College Magazine,* College of Agriculture, Nagpur.
Kisan (Hindi). Quarterly. Annual subscription Rs. 2, As. 8 per copy.	Issued by the Agricultural Association, Bihar and Orissa.	B. N. Sircar, Senior Marketing Officer and Editor, *Kisan,* Patna.
Annual Report of the Imperial Council of Agricultural Research for the years 1934-35 and 1935-36.	Issued by the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.
Review of Agricultural Operations in India, 1931-33.	Ditto	Ditto.
Proceedings of the First Meeting of the Crops and Soils Wing of the Board of Agriculture and Animal Husbandry in India held at Delhi from 25th February to 2nd March, 1935, with Appendices. Price Rs. 6.	Ditto	Ditto.
The Silk Industry of Japan, with Notes on Observations in the United States of America, England, France and Italy. Scientific Monograph No. 8 of the Imperial Council of Agricultural Research. Price Rs. 4 or 6*s.* 9*d.* (As. 8).	C. C. Ghosh	Ditto.
Mechanical Cultivation in India. A History of the Large-scale Experiments carried out by Burma-Shell Oil Storage and Distributing Company of India, Ltd. Scientific Monograph No. 9 of the Imperial Council of Agricultural Research. Price Rs. 3-14 or 6*s.* 6*d.*	C. P. G. Wade	Ditto.
A Bund-forming Implement. (Telugu). Leaflet No. 61 of the Department of Agriculture, Madras.	N. G. Charley	Government Press, Madras.
Cotton (Telugu). Leaflet No. 66 of the Department of Agriculture, Madras.	A. C. Edmonds	Ditto.
Notes on Turmeric (Reprinted). Leaflet No. 2 of the Department of Agriculture, Madras.	Issued by the Department of Agriculture, Madras.	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
How to send Specimens for examination (English and Tamil) (Reprinted). Leaflet No. 21 of the Department of Agriculture, Madras.	S. Srinivasa Ayyangar .	Government Press, Madras.
How to increase Crop Yields and maintain Good Health (Telugu). Note No. 13 of the Department of Agriculture, Madras.	T. Budhavidheya Rao .	Ditto.
Villagers' Calendar for 1936 (Calendar year).	Issued by the Department of Agriculture, Madras.	Ditto.
Villagers' Calendar for 1935-36 (September 1935 to September 1936) (Malayalam).	Ditto .	Ditto.
Reports of the Subordinate Officers of the Department of Agriculture, Madras, 1934-35. Price Rs. 4-4-0.	Ditto .	Ditto.
How to send Specimens for examination (Telugu, Malayalam, Kanarese) (Reprinted).	S. Srinivasa Ayyangar .	Ditto.
Descriptive Notes on improved strains from important varieties of Paddy evolved at the Agricultural Research Station, Maruteru.	K. Ramiah . . .	Ditto.
The preparation in home of Infant and Invalids Food from *cholam* (Reprinted).	B. Visvanath . .	Ditto.
No Water-rate or *Fasljasti* for certain crops, concessions made by Government to ryots in aid of cultivation.	Issued by the Department of Agriculture, Madras.	Ditto.
Annual Report of the Department of Agriculture, Bombay, 1934-35. Price As. 10.	Department of Agriculture, Bombay.	Government Central Press, Bombay.
Improved Ploughs designed and locally constructed to suit the Bengali cultivators (Bengali and English). Leaflet No. 2 of 1936 of the Department of Agriculture, Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Alipore, Bengal.
Cultivation of Cold Weather Vegetables in Union Board Demonstration Centres (English and Bengali). Leaflet No. 4 of 1936 of the Department of Agriculture, Bengal.	Ditto .	Ditto.
Cultivation of Gram (English and Bengali). Leaflet No. 5 of 1936 of the Department of Agriculture, Bengal.	Ditto .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
Cultivation of Linseed in Bengal (English and Bengali). Leaflet No. 6 of 1936 of the Department of Agriculture, Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Alipore, Bengal.
A short note on improving by quality of fibre Sann-hemp by scutching. Leaflet No. 7 of 1936 of the Department of Agriculture, Bengal.	Ditto	Ditto.
Agricultural Implements, Part I (Hindi). Leaflet No. 10 of the Department of Agriculture, United Provinces.	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, United Provinces, Allahabad.
Agricultural Implements, Part II (Urdu and Hindi). Leaflet No. 11 of the Department of Agriculture, United Provinces.	Ditto	Ditto.
Suttan Cane-crusher (Urdu). Leaflet No. 18 of the Department of Agriculture, United Provinces.	Ditto.	Ditto.
The Cultivation of ordinary smoking and chewing Tobacco in the United Provinces. Leaflet No. 27 of the Department of Agriculture, United Provinces.	Ditto	Ditto.
Short note on *Kharif* Cultivation. Leaflet No. 30 of the Department of Agriculture, United Provinces.	Ditto	Ditto.
Report of the Administration of the Department of Agriculture, United Provinces of Agra and Oudh for the year ending 30th June, 1935. Price As. 12.	Ditto	Ditto.
Soaking of Cotton Seeds before sowing. Leaflet No. 128 of the Department of Agriculture, Punjab.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
Growing of Cigarette Tobacco in the Punjab. Leaflet No. 129 of the Department of Agriculture, Punjab.	Ditto	Ditto.
Annual Report of the Department of Agriculture, Punjab, for the year ending 30th June, 1935. Price Re. 1 per copy.	Ditto	Ditto.
A booklet on the Experiments at the Agricultural Stations, Hansi-Hissar district. Price As. 12.	Ditto	Ditto.
Prospectus of the Punjab Agricultural College, Lyallpur. Free.	Ditto	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
Instructions for sowing improved varieties of Rice on the Upper Chenab Canal. Leaflet No. 134 of the Department of Agriculture, Punjab. Free.	Issued by the Department of Agriculture, Punjab.	Government Printing Punjab, Lahore.
Suitable Sugarcane areas in Mytkyina district. Agricultural Survey No. 21 of 1935 of the Department of Agriculture, Burma.	Issued by the Department of Agriculture, Burma.	Government Printing and Stationery, Burma, Rangoon.
The Sugarcane Soil of Burma. Agricultural Survey No. 22 of 1935 of the Department of Agriculture, Burma.	Ditto	Ditto.
Power and Industrial Alcohol-possibilities of manufacture in Burma. Agricultural Survey No. 24 of the Department of Agriculture, Burma.	Ditto	Ditto.
Soap-making by cold process. Cultivators' Leaflet No. 79 of the Department of Agriculture, Burma.	Ditto	Ditto.
Annual Report of the Department of Agriculture, Bihar and Orissa, 1934-35.	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Gulzarbagh, Patna.
Annual Report on Experimental Farms in Bihar and Orissa, 1934-35.	Ditto	Ditto.
Cultivation of Sugarcane in North Bihar. Bulletin No. 3 of 1934-35 of the Department of Agriculture, Bihar and Orissa.	Ditto	Ditto.
Irrigation by a 3 H. P. portable power-pumping plant. Leaflet No. 2 of 1936 of the Department of Agriculture, Bihar and Orissa.	Ditto	Ditto.
Report on the working of the Department of Agriculture, Central Provinces for the year ending the 31st March 1935. Price Re. 1-6-0.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
Annual Reports on Experimental Farms, Nagpur, Akola, Adhartal, Chhindwara, Powarkhera and Raipur for the year ending the 31st March 1935.	Ditto	Ditto.
Report on Demonstration work carried out in the Southern Circle, C. P., together with reports on seed and demonstration and cattle-breeding farms of the circle for the year ending the 31st March 1935.	Ditto	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
Reports on Demonstration work carried out in the Northern Circle, Central Provinces, together with reports on the seeds and demonstration and cattle-breeding farms of the circle for the year ending the 31st March 1935.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
Report on Demonstration work carried out in the Western Circle, Central Provinces, together with reports on the seed and demonstration and cattle-breeding farms of the circle for the year ending the 31st March 1935.	Ditto	Ditto.
Report on Demonstration work carried out in the Eastern Circle, Central Provinces, together with reports on the seed and demonstration and cattle-breeding farms of the circle for the year ending the 31st March 1935.	Ditto	Ditto.
Report on the Agricultural College, Nagpur, for the year ending the 31st March 1935.	Ditto	Ditto.
Report on the Engineering Section, Agricultural College, Nagpur, for the year ending the 31st March 1935.	Ditto	Ditto.
A leaflet on Improvement of Cotton in the Central Provinces and Berar (English, Hindi and Marathi).	Ditto	Ditto.
A leaflet on Soybean (*Glycine hispida*) (English and Marathi).	Ditto	Ditto.
Annual Report of the Department of Agriculture, Assam, for the year 1934-35.	Issued by the Department of Agriculture, Assam.	Assam Government Press, Shillong.
Hints on the Improvement of Cultivated Crops. Bulletin No. 8 of 1935 of the Department of Agriculture, Assam.	Ditto	Ditto.
Annual Report of the Department of Agriculture in Sind, for the year 1934-35.	Issued by the Department of Agriculture, Sind.	The Daily Gazette Press, Ltd., Karachi.
A Five-year Programme of the Agricultural Development in Sind.	Ditto	Ditto.
Annual Administration Report of the Department of Agriculture, Hyderabad, for the year 1342 Fasli.	Issued by the Department of Agriculture, Hyderabad.	Government Central Press, Hyderabad—Deccan.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
Improvement of Coffee in the Netherlands East Indies (Kannada). General Series. Bulletin No. 15 of the Department of Agriculture, Mysore Government.	Leslie C. Coleman . .	Superintendent, Government Press, Bangalore.
Mysore Agricultural Calendar (English and Kannada). Price English As. 2; Kannada Anna 1.	Issued by the Department of Agriculture, Mysore.	Ditto.
Preservation of Coffee Baskets in the nursery (English and Kannada). Circular No. 4 of the Mysore Coffee Experiment Station, Balehonnur.	K. H. Srinivasan . .	Ditto.
Annual Report of the Coffee Scientific Officer, 1935-36 (Mysore Coffee Experiment Station Bulletin No. 14). Price As. 4.	W. Wilson Mayne . .	Ditto.
Tobacco Cultivation	G. Sivarama Pillai . .	Government Press, Travancore.
Cultivation of Chillies . . .	M. C. George . .	Ditto.
Selection of Seed Paddy . . .	N. Narayanan Tampi .	Ditto.
Preparation of Turmeric for the Market	P. K. Krishna Pillai .	Ditto.
Improvements in the methods of manufacturing Palm Jaggery (English and Malayalam) (Leaflet).	Issued by the Department of Agriculture, Cochin.	Cochin Government Press, Ernaculam.
Certain Hygienic principles useful to Men and Cattle (Malayalam) (Leaflet).	Ditto .	Ditto.
Trained Labour (Malayalam) (Leaflet) .	Ditto .	Ditto.
Annual Report of the Department of Agriculture, Gwalior Government for the year 1933-34.	Issued by the Department of Agriculture, Gwalior Government	Elijah Durbar Press, Gwalior.
Annual Report of the Indian Central Cotton Committee for the year ending 31st August 1935.	Issued by the Secretary, Indian Central Cotton Committee.	Indian Central Cotton Committee, Bombay.
Summary Proceedings of the 31st Meeting of the Indian Central Cotton Committee held on the 19th and 20th August 1935.	Ditto .	Ditto.
Indian Central Cotton Committee—Its objects and activities and achievements (2nd edition).	Issued by the Publicity Officer, Indian Central Cotton Committee.	Ditto.
Elimination of Goghari from the Navsari Tract (English and Gujarati).	Ditto .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
GENERAL AGRICULTURE—*contd.*		
Save Indian Cotton (English and Gujarati).	Issued by the Publicity Officer, Indian Central Cotton Committee.	Indian Central Cotton Committee, Bombay.
Plant-puller. Leaflet in Gujarati (2nd edition).	Ditto .	Ditto.
Elimination of Goghari from the Surat Tract will re-establish the reputation of Navsari cotton (English and Gujarati). Pamphlet. Gratis.	Ditto .	Ditto.
Summary of the 32nd Half-yearly Meeting of the I ndian Central Cotton Committee. Gratis.	Ditto .	Ditto.
The Sanitary Disposal and Agricultural Utilization of Habitation Wastes by the "Indore Process". Bulletin No. 1 of the Institute of Plant Industry, Indore (revised edition).	F. K. Jackson and Y. D. Wad.	Director, Institute of Plant Industry, Indore.
The Supply of Humus to Soils. Bulletin No. 2 of the Institute of Plant Industry, Indore.	F. K. Jackson, Y. D. Wad and V. G. Panse.	Ditto.
Studies in the Technique of Field Experiments, I. Size, shape and arrangement of plots in cotton trials. II. Sampling for staple length determination in cotton trials. III. An application of the method of co-variance to selection for disease-resistance in cotton. IV. A study of margin effect in variety trials with cotton and wheat. Bulletin No. 4 of the Institute of Plant Industry, Indore.	J. B. Hutchinson and V. G. Panse.	Ditto.
An Analysis of the Efficiency of Selection methods used in the Improvement of Malvi cotton. (Re-printed as Bulletin No. 5 of the Institute of Plant Industry, Indore).	J. B. Hutchinson and Kuber Singh.	Ditto.
The Introduction of improved strains of Crop Plants in Central India and Rajputana. (Re-printed as Bulletin No. 6 of the Institute of Plant Industry, Indore).	J. B. Hutchinson and V. G. Panse.	Ditto.
Tea Manufacture in South India. Price Rs. 5 for members and Rs. 10 for non-members.	K. B. W. Jones . .	The Secretary, United Planters' Association of South India, Glen View, Coonoor, Nilgiris.
Report by the Chief Scientific Officer on the work of the Scientific Department of the Indian Tea Association for the year 1934.	Issued by the Chief Scientific Officer, Indian Tea Association.	Catholic Orphan Press, Calcutta.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
AGRICULTURAL STATISTICS		
Indian Tea Statistics, 1934 . .	Issued by the Department of Commercial Intelligence and Statistics, India, Calcutta.	Manager of Publications, Delhi.
Agricultural Statistics of India, 1933-34, Vol. II. Price Rs. 5.	Ditto .	Ditto.
Season and Crop Report of the Madras Presidency for the year 1934-35. Price Re. 1-2-0.	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
Season and Crop Report of the Bombay Presidency. Price As. 8.	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
Season and Crop Report of Bengal for 1935-36.	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Alipore, Bengal.
Season and Crop Report of the United Provinces of Agra and Oudh for the year 1934-35. Price Re. 1.	Issued by the Department of Land Records, United Provinces of Agra and Oudh.	Government Printing and Stationery, United Provinces, Allahabad.
Season and Crop Report for the year ending 30th June, 1935. Price Rs. 3-8-0.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
Agricultural Statistics, 1934-35 . .	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Gulzarbagh, Patna.
Season and Crop Report, Bihar and Orissa, 1935-36.	Ditto .	Ditto.
Report on the Season and Crops of the North-West Frontier Province for the year 1934-35. Price Re. 1-1-0.	Issued by the Department of Agriculture, North-West Frontier Province.	Manager, Government Stationery and Printing, North-West Frontier Province, Peshawar.
Season and Crop Report, Sind, 1934-35	Issued by the Department of Agriculture, Sind.	The Daily Gazette Press, Ltd., Karachi.
Supply and Distribution of the various types of Indian cotton during the season of 1933-34. Statistical Bulletin No. 4.	Issued by the Secretary, Indian Central Cotton Committee.	Indian Central Cotton Committee, Bombay.
Stocks of Indian Raw Cottons held in India by the mills and the trade on 31st August 1935. Statistical Leaflet No. 2. (Second Issue, 1934-35.)	Ditto .	Ditto.
Receipts at mills in India of Raw Cotton classified by varieties 1934-35 season. Statistical Leaflet No. 3. (Second issue, 1934-35.)	Ditto .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
AGRICULTURAL STATISTICS—*contd.*		
Report on the Staple Length of the Indian Cotton crop of 1935-36. Third issue (1935-36). Statistical Leaflet No. 1 of the Indian Central Cotton Committee.	Issued by the Secretary, Indian Central Cotton Committee.	Indian Central Cotton Committee, Bombay.
SUGAR RESEARCH		
Cultivation of Sugarcane. Leaflet No. 2 of 1935 of the Department of Agriculture, Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Alipore, Bengal.
Cultivation of Sugarcane (Bengali). Leaflet No. 7 of 1935 of the Department of Agriculture, Bengal.	Ditto	Ditto.
Instructions on Ratooning Sugarcane in Bengal (Bengali). Leaflet No. 1 of 1936 of the Department of Agriculture, Bengal.	Ditto	Ditto.
Farming of Sugarcane in Tube-well Areas. Bulletin No. 68 of the Department of Agriculture, United Provinces.	R. G. Allan	Government Printing and Stationery, United Provinces, Allahabad.
Sugarcane Varieties. Cultivators' Leaflet No. 78 of the Department of Agriculture, Burma.	Issued by the Department of Agriculture, Burma.	Government Printing and Stationery, Burma, Rangoon.
Cultivation of Sugarcane in South Bihar. Bulletin No. 1 of 1936 of the Department of Agriculture, Bihar.	Issued by the Department of Agriculture, Bihar.	Government Printing, Bihar, Gulzarbagh, Patna.
Report on the Development of Sugarcane Cultivation in Nizam Sagar Canal Area. Bulletin No. 9 of the Hyderabad Agricultural Department.	T. S. Venkatraman	Government Central Press, Hyderabad—Deccan.
Sugarcane Cultivation on the Irwin Canal Farm (General Series, Bulletin No. 19) (English and Kannada).	B. Narasimha Iyengar	Superintendent, Government Press, Bangalore.
Sugarcane Varieties	V. Narayanan Nair	Government Press, Travancore.
The Indore Method of Sugarcane Cultivation. Leaflet No. 13 of the Institute of Plant Industry, Indore.	Issued by the Director, Institute of Plant Industry, Indore.	Director, Institute of Plant Industry, Indore.
Humus Manufacture from Cane Trash. Bulletin No. 3 of the Institute of Plant Industry, Indore.	G. C. Tambe and Y. D. Wad.	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
COTTON TECHNOLOGY.		
Technological Reports on Standard Indian Cottons, 1935. (Tech. Bull. Series A, No. 28.) Re. 1-8.	Nazir Ahmad . .	Indian Central Cotton Committee, Vulcan House, Ballard Estate, Bombay.
Technological Reports on Trade Varieties of Indian Cottons, 1935. (Tech. Bull. Series A, No. 29.) Re. 1-8.	Ditto . . .	Ditto.
The Effects of Storing Cotton Bales in the open and inside a shed at Karachi. (Tech. Bull. Series A, No. 30.) As. 8.	Ditto . . .	Ditto.
Quality of Lint in relation to Ginning factors, Part I. The effect of (i) moving knife-setting and (ii) saw speed. (Tech. Bull. Series A, No. 31.) Re. 1.	Nazir Ahmad and R. P. Richardson.	Ditto.
Fibre-maturity in relation to Fibre and Yarn characteristics of Indian Cottons. (Tech. Bull. Series B, No. 20.) As. 8.	A. N. Gulati and Nazir Ahmad.	Ditto.
Spinning Test and Technological Reports on 1935-36 samples of—		
Gadag I (Dharwar-American) (T. C. No. 167).	Nazir Ahmad . .	Ditto.
Latur cotton (T. C. No. 168) . .	Ditto . . .	Ditto.
Nanded cotton (T. C. No. 169) .	Ditto . . .	Ditto.
Muttia cotton (T. C. No. 170) .	Ditto . . .	Ditto.
Broach cotton (T. C. No. 171) .	Ditto . . .	Ditto.
Jagadia cotton (T. C. No. 172) .	Ditto . . .	Ditto.
Punjab-American cotton (T. C. No. 173).	Ditto . . .	Ditto.
Bailhongal cotton (T. C. No. 174) .	Ditto . . .	Ditto.
Broach cotton (T. C. No. 175) .	Ditto . . .	Ditto.
Karunganni cotton (T. C. No. 176) .	Ditto . . .	Ditto.
Tirupur Cambodia cotton (T. C. No. 177).	Ditto . . .	Ditto.
Northern Cambodia cotton (T. C. No. 178).	Ditto . . .	Ditto.
Farm Western cotton (T. C. No. 179)	Ditto . .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
COTTON TECHNOLOGY—*contd.*		
Westerns cotton (T. C. No. 180) .	Nazir Ahmad . .	Indian Central Cotton Committee, Vulcan House, Ballard Estate, Bombay.
Miraj cotton (T. C. No. 181) . .	Ditto . . .	Ditto.
Nandyal cotton (T. C. No. 182) .	Ditto . . .	Ditto.
Surat cotton (T. C. No. 183) . .	Ditto . . .	Ditto.
Tiruppur Cambodia cotton (T. C. No. 184).	Ditto . . .	Ditto.
African Busoga cotton (T. C. No. 185)	Ditto . . .	Ditto.
Kampala cotton (T. C. No. 186) .	Ditto . . .	Ditto.
Hubli Upland cotton (T. C. No. 187)	Ditto . . .	Ditto.
Punjab-American 4-F cotton (T. C. No. 188).	Ditto . . .	Ditto.
Surat 1027 A L F cotton (T. C. No. 189).	Ditto . . .	Ditto.
Kalagin cotton (T. C. No. 190) .	Ditto . . .	Ditto.
Farm Westerns cotton (T. C. No. 191)	Ditto . . .	Ditto.
Jayawant (Kumpta) cotton (T. C. No. 192).	Ditto . . .	Ditto.
Cambodia Co 2 (Cambodia 440) cotton (T. C. No. 193).	Ditto . . .	Ditto.
Navsari cotton (T. C. No. 194) .	Ditto . . .	Ditto.
Upland cotton (T. C. No. 195) .	Ditto . . .	Ditto.
Dholleras cotton (T. C. No. 196) .	Ditto . . .	Ditto.
Westerns cotton (T. C. No. 197) .	Ditto . . .	Ditto.
Surat cotton (T. C. No. 198) . .	Ditto . . .	Ditto.
Tinnevelly cotton (T. C. No. 199) .	Ditto . . .	Ditto.
Cambodia cotton (T. C. No. 200) .	Ditto . . .	Ditto.
Karunganni cotton (T. C. No. 201) .	Ditto . . .	Ditto.
Bijapur cotton (T. C. No. 202) .	Ditto . . .	Ditto.
Bagalkote cotton (T. C. No. 203) .	Ditto . . .	Ditto.
A. R. Jinja cotton (T. C. No. 204) .	Ditto . . .	Ditto.
A. R. Busoga cotton (T. C. No. 205)	Ditto . . .	Ditto.
A. R. Kampala cotton (T. C. No. 206)	Ditto . . .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
COTTON TECHNOLOGY—*concld.*		
Kumpta cotton (T. C. No. 207) .	Nazir Ahmad . .	Indian Central Cotton Committee, Vulcan House, Ballard Estate, Bombay.
Punjab-American 289-F (T. C. No. 208).	Ditto . . .	Ditto.
Ujjain cotton (T. C. No. 209) . .	Ditto . . .	Ditto.
Bengals cotton (T. C. No. 210) .	Ditto . . .	Ditto.
Kandesh cotton (T. C. No. 211) .	Ditto . . .	Ditto.
Moglai cotton (T. C. No. 212) .	Ditto . . .	Ditto.
Ujjain (Mandusar) cotton (T. C. No. 213).	Ditto . . .	Ditto.
Verum 262 (Nagpur) cotton (T. C. No. 214).	Ditto . . .	Ditto.
Verum 262 (Akola) cotton (T. C. No. 215).	Ditto . . .	Ditto.
V. 434 (Akola) cotton (T. C. No. 216)	Ditto . . .	Ditto.
Late Verum (Nagpur) (T. C. No. 217)	Ditto . . .	Ditto.
Umri Bani cotton (T. C. No. 218) .	Ditto	Ditto.
Punjab-American 4-F cotton (T. C. No. 219).	Ditto . . .	Ditto.
Nanded cotton (T. C. No. 220) .	Ditto . . .	Ditto.
C. P. No. 1 cotton (T. C. No. 221) .	Ditto . . .	Ditto.
Latur cotton (T. C. No. 222) . .	Ditto . . .	Ditto.
Punjab-American cotton (T. C. No. 223).	Ditto . . .	Ditto.
Muttia cotton (T. C. No. 224) (Price As. 4 only.) .	Ditto . . .	Ditto.
FRUITS		
Selection work in the Coconut. Leaflet No. 52 of the Department of Agriculture, Madras. (Reprinted.)	K. W. Chakrapani Marar	Government Press, Madras.
The Improvement of the Coconut under dry cultivation. Leaflet No. 59 of the Department of Agriculture, Madras. (Reprinted.)	Ditto . .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
	FRUITS—*contd.*	
Coconut Cultivation	J. S. Patel . . .	Government Press, Madras.
A note on Pineapple Cultivation (Urdu and Hindi). Bulletin No. 9 F. S. of the Department of Agriculture, United Provinces.	V. Sane . . .	Government Printing and Stationery, Allahabad.
Notes on Fruit Culture in the hills (Urdu and Hindi). Bulletin No. 10 F. S. of the Department of Agriculture, United Provinces.	J. G. Burns . . .	Ditto.
Sundry papers on Fruit Development, fruit growers' organisation and the necessity of improving the basis of marketing (Urdu). Bulletin No. 11 F. S. of the Department of Agriculture, United Provinces.	R. G. Allan . . .	Ditto.
The *Lichi* (English and Hindi). Bulletin No. 12 F. S. of the Department of Agriculture, United Provinces.	N. D. Viyas . . .	Ditto.
Modern Mango Cultivation. Bulletin No. 13 F. S. of the Department of Agriculture, United Provinces.	R. G. Allan . . .	Ditto.
Some aspects of Heading back and Topworking fruit series. Bulletin No. 15 F. S. of the Department of Agriculture, United Provinces.	Issued by the Department of Agriculture, United Provinces.	Ditto.
Safeguarding Fruit trees From heat, cold and wind. Bulletin No. 16 (Fruit Series) of the Department of Agriculture, United Provinces.	Ditto . .	Ditto.
Some methods of Preserving and Utilising Fruits. Bulletin No. 17 (Fruit Series) of the Department of Agriculture, United Provinces.	Ditto . .	Ditto.
The Mangosteen in Burma. Agricultural Survey No. 23 of the Department of Agriculture, Burma.	Issued by the Department of Agriculture, Burma.	Government Printing and Stationery, Burma, Rangoon.
Papaya. Leaflet No. 1 of 1936 of the Department of Agriculture, Orissa.	Issued by the Department of Agriculture, Orissa.	Orissa Government Press, Cuttack.
Cashewnut Cultivation . . .	M. C. George . .	Government Press, Travancore.
Bagging of Pomegranates . . .	M. Madhavan . .	Ditto.
Graft Mangoes (Malayalam) (Leaflet) .	Issued by the Department of Agriculture, Cochin.	Cochin Government Press, Ernakulam.
Ginger Cultivation (Malayalam) (Leaflet).	Ditto . .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
LAC		
Annual Report of the Indian Lac Research Institute for the year 1st April 1934 to 31st March 1935.	Issued by the Director, Indian Lac Research Institute, Namkum.	The Indian Lac Research Institute, Namkum, Ranchi.
A simple method for the forecast of emergence of Lac Larvae (Hindi and Bengali).	P. S. Negi . . .	Ditto.
Further note on the Chalcidoid parasite of *Laccifer lacca* Kerr. Bulletin No. 22.	P. M. Glover . .	Ditto.
Lac and the Indian Lac Research Institute. (2nd edition.)	Dorothy Norris, P. M. Glover and R. W. Aldis.	Ditto.
Shellac Patent Index . . .	R. W. Aldis . . .	Ditto.
The Heat-curing of Shellac, Part I. "The life under heat". (Revised edition.)	Issued by the Director, Indian Lac Research Institute, Namkum.	Ditto.
Shellac Industry	Ditto . . .	Ditto.
AGRICULTURAL SCIENCE—GENERAL		
Indian Journal of Agricultural Science, Vol. V, parts 4, 5 and 6; and Vol. VI, parts 1, 2 and 3. Annual subscription Rs. 15 or 24*s*. (Original scientific work in the various branches of science applied to agriculture, formerly published in the Memoirs of the Imperial Department of Agriculture in India is now published in the *Indian Journal of Agricultural Science*.)	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.
Scientific Report of the Imperial Institute of Agricultural Research, Pusa, for the year 1933-34 including the Reports of the Imperial Dairy Expert, Physiological Chemist and Sugarcane Expert.	Issued by the Director, Imperial Institute of Agricultural Research, Pusa.	Ditto.
A Handbook of Statistics for use in Plant-breeding and Agricultural Problems. Issued by the Imperial Council of Agricultural Research.	F. J. F. Shaw . .	Ditto.
Statistical Methods and their Application to Agronomy. A bibliography. Miscellaneous Bulletin No. 9 of the Imperial Council of Agricultural Research. Price Rs. 2-2-0 or 2*s*.	K. K. Guha Roy . .	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
AGRICULTURAL SCIENCE—GENERAL—*contd.*		
Tables of Standard Errors of Mendelian ratios. Miscellaneous Bulletin No. 11 of the Imperial Council of Agricultural Research. Price As. 12 or 1*s.* 3*d.*	Swarn Singh Purewal and P. Krishna Rao.	Manager of Publications, Delhi.
Two new Statistical Tables based on Fisher's '*t*'. Miscellaneous Bulletin No. 13 of the Imperial Council of Agricultural Research. Price As. 6 or 8*d.*	M. Vaidyanathan . .	Ditto.
BOTANY		
Report on the Botanical Research, Agricultural College, Nagpur, for the year ending the 31st March, 1935.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
Improvement of Rice in the Bombay Karnatak, Part I. Selection in the Mugad and Antersal varieties of rice. Bulletin No. 178 of 1935 of the Department of Agriculture, Bombay.	S. S. Salimath and T. R. Khadilkar.	Government Central Press, Bombay.
CHEMISTRY AND PHYSICAL CHEMISTRY		
Making of Poudrette from night-soil (Tamil, Telugu, Kanarese and Malayalam). Leaflet No. 67 of the Department of Agriculture, Madras.	P. V. Ramiah . .	Government Press, Madras.
Utilization of Water-hyacinth as Manure (Urdu and Hindi.) Leaflet No. 24 of the Department of Agriculture, United Provinces.	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, United Provinces, Allahabad.
Study of the Evaporation of Water from Soil surface with reference to the fluctuations of Water-table. Issued by the Irrigation Research Institute, Lahore.	V. I. Vaidhianathan and Hans Raj Luthra.	Government Printing, Punjab, Lahore.
Nitrogenous and Phosphate Fertilizers experiment on Sugarcane at the Central Farm, Pyinmana. Cultivators' Leaflet No. 77 of the Department of Agriculture, Burma.	Issued by the Department of Agriculture, Burma.	Government Printing and Stationery, Burma, Rangoon.
Note on Compost-making (Hindi). Leaflet No. 1 of 1936 of the Department of Agriculture, Bihar.	Issued by the Department of Agriculture, Bihar.	Government Printing, Bihar, Gulzarbagh, Patna.
Report on the Chemical Research, Agricultural College, Nagpur, for the year ending the 31st March, 1935.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Province,s Nagpur.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
CHEMISTRY AND PHYSICAL CHEMISTRY—*contd.*		
Nitrogen balance in Black Cotton Soils in Malwa Plateau, II. Changes during the hot weather.	Yashwant D. Wad and R. K. Aurangabadkar.	Issued by the Director, Institute of Plant Industry, Indore.
The Supply of Humus to Soils. Bulletin No. 2 of the Institute of Plant Industry, Indore. (Reprinted and Revised.)	F. K. Jackson, Y. D. Wad and V. G. Panse.	Ditto.
PLANT DISEASES		
Influence of Manure on the Wilt disease of *Cajanus indicus* Spreng. and the Isolation of the Types resistant to the Disease. Scientific Monograph No. 7 of the Imperial Council of Agricultural Research. Price Rs. 2-4-0 or 4*s.* 3*d.* (As. 5.)	W. McRae and F. J. F. Shaw.	Manager of Publications, Delhi.
Disease of Sugarcane and methods for their control. Miscellaneous Bulletin No. 10 of the Imperial Council of Agricultural Research. Price Re. 1-14-0 or 3*s.* 3*d.*	L. S. Subramaniam	Ditto.
Report on the Mycological Research, Agricultural College, Nagpur, for the year ending the 31st March, 1935.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
Studies in Disease Resistance, I. Cotton wilt and environment.	K. N. Ambegaonkar and Yashwant D. Wad.	Issued by the Director, Institute of Plant Industry, Indore.
Studies in Disease Resistance, II. Leaf-roll and Red-leaf of American cotton.	I. Madhusudan Rao and Yeshwant D. Wad.	Ditto.
ENTOMOLOGY		
List of Publications on Indian Entomology (1934). Miscellaneous Bulletin No. 7 of the Imperial Council of Agricultural Research. Price Re. 1-2-0 or 2*s.*	Compiled by the Officiating Imperial Entomologist and the Imperial Entomologist, Pusa.	Manager of Publications, Delhi.
Thes Spotted Boll-worms of Cotton in South Gujarat. Scientific Monograph No. 10 of the Imperial Council of Agricultural Research. Price Rs. 5-14-0 or 9*s.* 6*d.*	B. P. Deshpande and N. T. Nadkarny.	Ditto.
The House Fly Nuisance and its control with maggot traps (Telugu). Leaflet No. 64 of the Department of Agriculture, Madras.	T. V. Ramakrishna Iyer	Government Press, Madras.
Tokra. A pest on tobacco (Telugu). Leaflet No. 69 of the Department of Agriculture, Madras.	T. Budhavidheya Rao	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
	ENTOMOLOGY—*contd.*	
Smut on *Cholam* (Telugu). Leaflet No. 69 of the Department of Agriculture, Madras. (Reprinted.)	S. Sundararaman . .	Government Press, Madras.
Red Hairy Caterpillar Pest. (Reprinted) (English and Tamil).	T. V. Ramakrishna Ayyar	Ditto.
Pea Powdery Mildew in Bombay. Bulletin No. 177 of 1935 of the Department of Agriculture, Bombay.	B. N. Uppal, M. K. Patel and M. N. Kamat.	Government Central Press, Bombay.
Sugarcane Borer (Hindi). Leaflet No. 19 of the Department of Agriculture, United Provinces.	Issued by the Department of Agriculture, United Provinces.	Government Printing and Stationery, United Provinces, Allahabad.
The Pink Boll-worm pest of Cotton and how to control it (Urdu). Leaflet No. 21 of the Department of Agriculture, United Provinces.	Ditto . .	Ditto.
Stem-borer of Sugarcane (Urdu and Hindi). Leaflet No. 22 of the Department of Agriculture, United Provinces.	Ditto . .	Ditto.
Pyrilla attack on Sugarcane (Urdu). Leaflet No. 23 of the Department of Agriculture, United Provinces.	Ditto . .	Ditto.
Moth of a Borer of Sugarcane, Maize and *Juar*. Leaflet No. 25 of the Department of Agriculture, United Provinces.	Ditto . .	Ditto.
Red-rot of Sugarcane (Hindi). Leaflet No. 31 of the Department of Agriculture, United Provinces.	Ditto . .	Ditto.
Stinking rot of Sugarcane. Leaflet No. 32 of the Department of Agriculture, United Provinces.	Ditto . .	Ditto.
Wooly Aphis on Sugarcane in Myitkyina district. Cultivators' Leaflet No. 76 of the Department of Agriculture, Burma.	Issued by the Department of Agriculture, Burma.	Government Printing and Stationery, Burma, Rangoon.
Report on the Entomological Research, Agricultural College, Nagpur, for the year ending the 31st March, 1935.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
Spotted Boll-worms in South Gujarat. Pamphlet. Gratis.	Issued by the Publicity Officer, Indian Central Cotton Committee, Bombay.	Indian Central Cotton Committee, Bombay.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
ENTOMOLOGY—*concld.*		
Eradication of *Kans*. Leaflet No. 12 of the Institute of Plant Industry, Indore.	Issued by the Director, Institute of Plant Industry, Indore.	Director, Institute of Plant Industry, Indore.
San Jose Scale in Kashmir and its control.	M. R. Fotidar and Jia Lal Raina.	The Daily Gazette Press, Ltd., Karachi.
Sugarcane Borer Control in the Mysore State. Circular No. 55 of the Department of Agriculture, Mysore Government.	T. V. Subramanian	Superintendent, Government Press, Bangalore.
Insects that are Destructive to Coconut trees (Malayalam). Bulletin on Entomological Series.	Issued by the Department of Agriculture, Cochin.	Cochin Government Press, Ernaculam.
VETERINARY SCIENCE AND ANIMAL HUSBANDRY.		
Agriculture and Livestock in India, Vol. V, parts IV, V and VI, and Vol. VI, parts I, II and III. Annual subscription Rs. 6 or 9*s*. 9*d*. (A bi-monthly journal of agriculture and animal husbandry for the general reader interested in agriculture and livestock in India or the Tropics.).	Issued under the authority of the Imperial Council of Agricultural Research.	Manager of Publications, Delhi.
The Indian Journal of Veterinary Science and Animal Husbandry, Vol. V, parts III and IV, and Vol. VI, parts I and II. Annual subscription Rs. 6 or 9*s*. 9*d*. (A quarterly journal for the publication of scientific matter relating to health, nutrition and breeding of livestock).	Ditto	Ditto.
The Indian Veterinary Journal. (The journal of the All-India Veterinary Association.) Quarterly. Annual subscription Rs. 4 or 6*s*. 6*d*. for members and Rs. 8 or 10*s*. for others.	P. Srinivasa Rao (Editor)	The Editor, The *Indian Veterinary Journal*, 26, Wallajah Road, Madras.
The United Provinces Veterinary Magazine (English and Urdu). Monthly. Issued free to members of the United Provinces Veterinary Association.	Issued by the United Provinces Veterinary Association.	Editor, *United Provinces Veterinary Magazine*, Moradabad.
The Punjab Veterinary Journal	Issued by the Punjab Veterinary Association.	The Editor, *The Punjab Veterinary Journal*, Lahore.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*contd.*		
The Central Provinces Veterinary Journal. Quarterly.	Issued by the Central Provinces Veterinary Association.	The Honorary Secretary, Central Provinces Veterinary Association, Nagpur.
A description of the Imperial Institute of Veterinary Research, Muktesar, and its Substation, the Imperial Veterinary Serum Institute, Izat nagar. Price Re. 1-4-0 or 2*s*.	F. Ware . . .	Manager of Publications, Delhi.
Annual Report of the Imperial Institute of Veterinary Research, Muktesar, for the year ending 31st March 1935.	Issued by the Director, Imperial Institute of Veterinary Research, Muktesar.	Ditto.
Selected Clinical Articles [(1) An interesting outbreak of *Variola vaccinia* in milch cattle at Lahore; (2) An unusual case of navicular disease and (3) supernumerary tests in buffalo cows]. Miscellaneous Bulletin No. 8 of the Imperial Council of Agricultural Research.	G. K. Sharma and R. L. Kaura.	Ditto.
Annual Administration Report of the Madras Civil Veterinary Department for the year 1934-35. Price As. 12.	Issued by the Civil Veterinary Department, Madras.	Government Press, Madras.
Cattle Breeding	R. W. Littlewood . .	Ditto.
Breeding Bulls and their Management.	Ditto . .	Ditto.
Some Advantages of Poultry keeping (Re-printed).	Ditto . .	Ditto.
Housing of Poultry	Ditto . .	Ditto.
Aus paddy straw as Cattle food Bengali). Leaflet No 4 of 1936 of the Department of Agriculture, Bengal.	Issued by the Department of Agriculture, Bengal.	Bengal Government Press, Alipore, Bengal.
Leaflet containing revised Regulations regarding the Sale of Eggs for hatching purposes, and fowls for breeding purposes.	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
Sunflower (vernacular, *suraj mukhi*). Veterinary Bulletin No. 1 of 1933 of the Veterinary Department, Punjab. (Revised and reprinted 1935.)	Issued by the Director of Veterinary Services, Punjab.	Ditto.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—contd.

Title	Author	Where published
VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*contd.*		
Some Disease of Sheep in the low lands, etc., of the Punjab, with a particular reference to the control measures at the Government Cattle Farm, Hissar. Veterinary Bulletin No. 3 of 1935 of the Veterinary Department, Punjab.	Issued by the Director of Veterinary Services, Punjab.	Government Printing, Punjab, Lahore.
A Survey and Veterinary History of the Kangra district. Veterinary Bulletin No. 5 of the Veterinary Department, Punjab.	Ditto	Ditto.
List of Horse and Cattle Fairs and Shows in the Punjab and Punjab States during the year 1935-36.	Ditto	Ditto.
Annual Report of the Civil Veterinary Department, Punjab, for the year 1934-35.	Ditto	Ditto.
Prospectus of the Punjab Veterinary College, Lahore, for the session 1936-37.	Ditto	Ditto.
Sheep Breeding at the Government Cattle Farm, Hissar. Veterinary Bulletin No. 4 of 1935 of the Department of Veterinary Services, Punjab.	Ditto	Ditto.
On the value of Fuzzy American Cotton seeds as feeding stuff. Leaflet No. 132 of the Department of Agriculture, Punjab. Free.	Ditto	Ditto.
Goat Breeding (Jamna Pari) at the Government Cattle Farm, Hissar. Veterinary Bulletin No. 6 of 1936 of the Department of Veterinary Services, Punjab.	Ditto	Ditto.
The Hay-box method of heating Milk for indigenous Ghee-making. Veterinary Bulletin No. 8 of 1936 of the Department of Civil Veterinary Services, Punjab.	Ditto	Ditto.
A Cattle Survey of the Rohtak district in the Punjab. Board of Economic Enquiry, Punjab, Publication No. 41.	Santokh Singh and R. Branford.	Civil and Military Gazette Press, Lahore.

List of Agricultural and Animal Husbandry Publications in India published during 1935-36—concld.

Title	Author	Where published
VETERINARY SCIENCE AND ANIMAL HUSBANDRY—*concld.*		
Report on the Maharajbagh Menagerie together with the external work of the Veterinary Inspector attached to the Agricultural College, Nagpur, for the year ending the 31st March, 1935.	Issued by the Department of Agriculture, Central Provinces.	Government Printing, Central Provinces, Nagpur.
A leaflet on advantages of early Castration in Goats (English, Hindi and Marathi).	Ditto	Ditto.
Annual Report of the Civil Veterinary Department of the Central Provinces and Berar for the year ending the 31st March 1935. Price Re. 1.	Issued by the Civil Veterinary Department, Central Provinces.	Ditto.
A Scheme for the improvement of Cattle in the Central Provinces and Berar (English, Hindi and Marathi). Leaflet No. 6 of the Department of Agriculture, Central Provinces.	Issued by the Department of Agriculture, Central Provinces.	Ditto.
Suggestions for Utilization of Donations received in response to the appeal of His Excellency the Viceroy (English, Hindi and Marathi). Pamphlet.	Ditto	Ditto.
Suggestions for Co-operation between the Revenue and Agriculture Department for giving effect to the scheme of the cattle improvement formulated by His Excellency the Viceroy (English, Hindi and Marathi). Pamphlet.	Ditto	Ditto.
The Conditions on which Bulls will be given out by the Agriculture Department for improvement of cattle (English and Marathi). Pamphlet.	Ditto	Ditto.
Annual Report of the Civil Veterinary Department, Assam, for 1934-35.	Issued by the Civil Veterinary Department, Assam.	Assam Government Press, Shillong.
Report of the Civil Veterinary Department, North-West Frontier Province, for the year 1934-35. Price Re. 1-3-0.	Issued by the Civil Veterinary Department, North-West Frontier Province.	Manager, Government Stationery and Printing, North-West Frontier Province, Peshawar.
Silage making from Grass in pits in dry regions. Leaflet No. 14 of the Institute of Plant Industry, Indore.	Issued by the Director, Institute of Plant Industry, Indore.	Director, Institute of Plant Industries, Indore.
Genetic Principles and the problem of Cross-breeding for Milk yield—Indian cattle.	J. B. Hutchinson and N. R. Joshi.	Issued by the Director, Institute of Plant Industry, Indore.

APPENDIX XIV

List of Research Schemes of the Imperial Council of Agricultural Research in operation to which funds had been allotted up to the end of 1936

Serial No.	Sanctioned Schemes
	A.—Sugar Schemes
1	Bureau of Sugar Standards.
2	Grant to Shahjahanpur Research Station for a detailed examination of new seedling canes.
3	Grants to the United Provinces, Bihar and Orissa and Punjab Governments for experiments in designing a satisfactory small power sugarcane-crushing mill.
4	Bombay-Deccan sugarcane research scheme.
5	Initiation of future research into the insect pests of sugarcane.
6	Scheme for the establishment of a sugarcane research station in Bihar and Orissa and for the appointment of a Sugarcane Specialist.
7	Scheme for the establishment of a Sub-station of the Coimbatore Imperial Sugarcane Station at Karnal.
8	Scheme of the Imperial Mycologist, Pusa, for research on ' Mosaic ' and other cane diseases at Pusa.
9	Grant to the Sugar Demonstration Section of the United Provinces Agricultural and Industrial Exhibition, 1936-37.
10	Bengal scheme for sugarcane crushing and *gur* boiling.
11	Sugarcane Seedling Testing Station at Dacca.
12	Grant to Mysore Durbar for breeding of thick canes.
13	Economic enquiry into the cost of production of crops in the principal sugarcane and cotton tracts in India.
14	Chief Economist and staff.
15	Research on the genetics of sugarcane at the Imperial Cane-Breeding Station, Coimbatore.
16	Research on sugarcane in the Madras Presidency.
17	Establishment of a sugarcane research station in the Punjab.
18	Investigation into various problems of sugar industry in the United Provinces.
19	Establishment of a research and testing station for the indigenous system of *gur* and sugar manufacture by the Sugar Technologist to the Council.
20	Extension of sugarcane work at the Jorhat Experimental Station, Assam.
21	Manufacture of cattle-feed from molasses at the Experimental Sugar Factory, Cawnpore.

List of Research Schemes of the Imperial Council of Agricultural Research in operation to which funds had been allotted up to the end of 1936—contd.

Serial No.	Sanctioned Schemes
	B.—General Agricultural Schemes
22	Botanical Sub-station at Karnal.
23	Grant to Dacca University.
24	Professor Mukerjee's scheme of research into properties of colloid soil constituents.
25	Statistical studies relating to agricultural work in India.
26	Grant to Principal, Agra College, Agra, for investigation into the rusts of wheat and barley.
27	Dr. Bhatnagar's scheme of research into physico-chemical properties and fertility of soil.
28	Professor Dastur's scheme of rice physiology.
29	Dr. Chaudhuri's scheme withertip of citrus trees.
30	Establishment of a new branch of agricultural meteorology under the Indian Meteorological Department, Poona.
31	Appointment of Physical Assistant on the staff of Agricultural Chemist, Bengal.
32	Co-ordinated schemes of rice research in Provinces.
33	Award of a prize for a bone-crusher worked by—
	(*a*) Animal power.
	(*b*) Mechanical power.
34	Special Locust Research staff.
35	Grant to the Punjab Government for locust research.
36	Locust Bureau.
37	Research work on potatoes in Madras.
38	Financial assistance to the Oil Technological Section of Harcourt Butler Technological Institute.
39	Investigation on the organic constituents of Indian soils by Professor J. C. Ghosh.
40	Preparation of cheap synthetic manure from town refuse and waste materials by the Indian Institute of Science, Bangalore.
41	Investigation of the chemistry of malting *cholam*.
42	Extension of work on " quality " in crops by the Indian Institute of Science.
43	Professor J. B. Seth's scheme for investigating an electric method of hygrometry.
44	Scheme of malting and brewing qualities of barleys in the United Provinces, Punjab and Bihar and Orissa.

List of Research Schemes of the Imperial Council of Agricultural Research in operation to which funds had been allotted up to the end of 1936—contd.

Serial No.	Sanctioned Schemes
	B.—General Agricultural Schemes—contd.
45	Grant to Bombay Government on account of Dr. Uppal's deputation in connection with the study of virus diseases in plants.
46	Statistical Section of the Bureau of Agricultural Intelligence.
47	Provincial scheme of fruit research, Bombay cold storage fruit scheme.
48	Horticultural schemes in the provinces of Madras, Bengal, Punjab, Central Provinces and Berar, United Provinces and Bihar and Orissa.
49	Dry farming research scheme in the Bombay-Deccan, Hyderabad, Madras and the Punjab.
50	Improvement of castor crop in India by His Exalted Highness the Nizam's Government.
51	Grants to Provincial Governments in connection with the marketing scheme.
52	Potato-breeding research in North India.
53	Tobacco co-operative experiments.
54	Award of medal for improvements in agriculture and animal husbandry.
55	Investigation of '*gangai*' pest of rice.
56	Research into nitrogen loss from soils and nitrogen fixation in soils, by Dr. N. R. Dhar.
57	Investigation into the method of extraction of flax fibre.
58	Establishment of a Sub-station of the Imperial Agricultural Research Institute for research on cigarette-tobacco at Guntur (Madras).
59	Research on citrus stock and grape vines in the Punjab.
60	Research on the linseed crop in Bengal.
61	Additional Research on oil-seeds in the Punjab.
62	Research on groundnut in the Madras Presidency.
63	Investigation on sann hemp in Central Provinces.
64	Research on plant physiology by Dr. Boshi Sen.
65	Training of an officer in Europe in gas storage of fruits and vegetables (Bombay).
66	Experimental work on the utilisation of bagasse for the paper and board manufacture at the Forest Research Institute.
67	Grant to Bengal Government for systematic collection of medicinal plants and study of food poisons in India by Colonel Chopra.
68	Investigation of Indian fish poisons and other Indian forest products for their insecticidal properties.

List of Research Schemes of the Imperial Council of Agricultural Research in operation to which funds had been allotted up to the end of 1936—concld.

Serial No.	Sanctioned Schemes
	C.—Animal Husbandry Schemes
69	Mr. A. E. Slater's scheme of goat-breeding.
70	Appointment of a Physiological Chemist to study animal nutrition at Dacca.
71	Appointment of Veterinary Investigation Officers in Provinces and Hyderabad State.
72	All-India Animal Husbandry Bureau.
73	Disease Investigation Officer, North-West Frontier Province.
74	Investigation into the most suitable and economic methods of combating different types of parasitic infection in ruminants in the fields, etc.
75	Investigation of Johne's diseases among cattle in Mysore.
76	Extension of work on animal nutrition in Madras Presidency.
77	Investigation for vaccination of cattle against rinderpest.
78	Research on warble flies.
79	Investigation of indigenous sheep-breeding in the Punjab.
80	Research in poultry husbandry in Bombay Presidency.
81	Feeding of minerals to cattle in Bihar and Orissa.
82	Investigation by Dr. H. K. Mukherjee regarding fresh water fish in Bengal.
83	Research on composition of milk.
84	Village enquiry regarding cattle and the production and consumption of milk.
85	Appointment of a Systematic Protozoologist at the Imperial Veterinary Research Institute.
86	Grant to the Government of the Punjab towards the cost of training of an assistant in agriculture in America and other countries.

APPENDIX XV

Key to the Diagrammatic Map of Agricultural Stations

Research Institutes, Agricultural and Veterinary Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			IMPERIAL AGRICULTURAL DEPARTMENT			
1. Pusa (Bihar)	1. Coimbatore (Madras) 2. Karnal-Botanical and Sugarcane Sub-stations (Punjab)				1. Pusa (Bihar) 2. Karnal (Punjab)	
			IMPERIAL DAIRY DEPARTMENT			
1. Bangalore	1. Anand (Research Creamery)					Wellington (*Nilgiris*)
			IMPERIAL VETERINARY DEPARTMENT			
1. Mukteswar (U. P.)	2. Izatnagar (U. P.)					

Key to the Diagrammatic Map of Agricultural Stations—contd.

Research Institutes, Agricultural and Veterinary Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			MADRAS			
			Agricultural Department			
1. Coimbatore	1. Berhampore*		1. Kalahasti		1. Hosur	1. Guntur
	2. Anakapalle					
	3. Samalkota					
	4. Maruteru					
	5. Guntur					
	6. Nandyal					
	7. Hagari					
	8. Anantarajupeta					
	9. Gudiyatham					
	10. Tindivanam					
	11. Palur					
	12. Adutural					
	13. Pattukottai					
	14. Koilpatti					
	15. Burliar					
	16. Coonoor					
	17. Kallar					
	18. Nanjanad					
	19. Pattambi					

	20. Taliparamba 21. Kasargod 22. Pillicode 23. Nileshwar					
2. Madras : (Veterinary College)			*Veterinary Department*			
			BOMBAY			
			Agricultural Department			
1. Poona	1. Surat 2. Nadiad 3. Dhulia 4. Dharwar 5. Karjat 6. Padegaon 7. Sholapur (Dry Farming Research Station) 8. Bijapur (Dry Farming Research Sub-station)	1. Ratnagiri 2. Dhulia 3. Jalgaon 4. Surat 5. Kirkee (Ganeshkhind Fruit Experimental Station) 6. Kirkee (Central Poultry Farm)	1. Kumta 2. Mugad 3. Gokak Canal 4. Hatkhamba 5. Mohol 6. Kopargaon 7. Broach 8. Dohad 9. Viramgam 10. Kundewadi, Niphad (Wheat Breeding Station)	1. Bhadgaon	1. Chharodi 2. Bankapur 3. Kirkee (Agricultural College Dairy)	1. Tegur 2. Surat
2. Bombay : (Veterinary College)			*Veterinary Department*			

* This station (Berhampore) is situated within the new Province of Orissa, but was under the control of the Department of Agriculture, Madras, during the period under review.

Key to the Diagrammatic Map of Agricultural Stations—contd.

Research Institutes, Agricultural and Veterinary Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			BENGAL			
			Agricultural Department			
1. Dacca	1. Berhampore	1. Dacca	1. Burdwan		1. Dacca	
	2. Rangpur	2. Chinsurah	2. Berhampore			
	3. Krishnagar	3. Rajshahi	3. Bankura			
	4. Chinsurah		4. Suri			
	5. Bankura		5. Krishnagar			
	6. Rangamati		6. Jessore			
	7. Kalimpong		7. Gosaba			
			8. Faridpur			
			9. Rangamati			
			10. Comilla			
			11. Barisal			
			12. Kishoreganj			
			13. Mymensingh			
			14. Pabna			
			15. Dhanbari			
			16. Bogra			
			17. Jamalpur			
			18. Rangpur			
			19. Malda			
			20. Dinajpur			

2. Calcutta : (Bengal Veterinary College)			21. Mainguri 22. Charbadna *Veterinary Department*		
1. Cawnpore (Agricultural College) 2. Bulandshahr (Agricultural School) 3. Gorakhpur (Agricultural School)	1. Shahjahanpore 2. Raya-Muttra 3. Cawnpore 4. Nagina	1. Gorakhpur 2. Partabgarh 3. Muzaffarnagar 4. Joolikote	UNITED PROVINCES *Agricultural Department* 1. Benares 2. Fyzabad 3. Etawah 4. Mainpuri 5. Bichpuri 6. Hardoi 7. Bahraich 8. Bulandshahr 9. Nigohi 10. Budaun 11. Nawabganj 12. Meerut 13. Attara 14. Hydergarh (Bara Banki) 15. Bara Banki 16. Unao 17. Kalianpur (Cawnpore) 18. Kahi (Aligarh)	1. Muttra 2. Khori 3. Bharari 4. Hempur	

Key to the Diagrammatic Map of Agricultural Stations—contd.

Research Institutes, Agricultural and Veterinary Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			PUNJAB			
			Agricultural Department			
1. Lyallpur	1. Risalewala	1. Lyallpur	1. Gurgaon	1. Fatna	1. Hissar	
	2. Sirsa (Botanical Sub-station)	2. Montgomery	2. Karnal	2. Shergarh		
	3. Rohtak (Dry Farming Research Station)	3. Hansi	3. Ambala	3. Vihari		
	4. Jullundur (Sugarcane Research Station)	4. Multan	4. Ludhiana	4. Risalewala		
		5. Jullundur	5. Beas	5. Chillianwala		
		6. Gurdaspur	6. Kangra	6. Sargodha		
		7. Kala Shah Kaku	7. Ferozepur	7. Multan		
		8. Rawalpindi	8. Gujranwala			
			9. Gujrat			
			10. Jhang			
			11. Mianwali			
			12. Campbellpur			
			13. Attari			
2. Lahore : (Punjab Veterinary College)			*Veterinary Department*			

1. Mandalay	1. Maungmya	BURMA	
	2. Hinawbi	*Agricultural Department*	
	3. Mudon	1. Paukkoung	1. Chibo
	4. Akyab	2. Sa-aing	2. Kyehmon
	5. Alhanmyo	3. Kyaukpyu	3. Singaing
	6. Pyinmana		4. Pwinbyu
	7. Mahlaing		5. Magwe
	8. Kanbalu		6. Pyu
			7. Paubgde
			8. Henzada
			9. Pegu
			10. Maubin
			11. Thaton
			12. Padu
			13. Nyaunglobin
			14. Pyapon
			15. Bassein
			16. Thegon Gwason
			17. Mibbya
			18. Mingan
			19. Myingyan
			20. Zigon
			21. Ye-U
2. Insein : (Veterinary College)		*Veterinary Department*	1. Tatkon

Key to the Diagrammatic Map of the Agricultural Stations—contd.

Research Institutes, Agricultural and Veterinary Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			BIHAR			
			Agricultural Department			
1. Sabour	1. Muzaffarpur (Sugarcane Research Station)	1. Kanke	1. Purulia		1. Kanke	
	2. Sabour (Rice Research Station)	2. Patna	2. Gaya		2. Sepaya	
		3. Sepaya	3. Neterhat			
		4. Sabour	4. Nawadah			
			5. Jamui			
			6. Banka			
			7. Darbhanga			
			8. Siwan			
			9. Bikramgunj			
			10. Siris			
			11. Chianki			
			12. Chaibasa			
2. Patna : (Bihar Veterinary College)			*Veterinary Department*		3. Phulwari	
			CENTRAL PROVINCES AND BERAR			
			Agricultural Department			
1. Nagpur	1. Akola	1. Powarkhera	1. Chhindwara	1. Saugor	1. Telinkheri	1. Richal
	2. Raipur	2. Adhartal	2. Tharsa	2. Bilaspur	2. Raigarh (Garhi)	2. Nagpur (Cattle Dairy Farm)
		3. Nagpur		3. Chandkhuri	3. Pendra	

				4. Drug 5. Seoni 6. Betul 7. Khandwa 8. Wara-Seoni 9. Yeotmal 10. Buldana 11. Bergaon 12. Sindewahi 13. Dindori	4. Ellichpur 5. Bod 6. Powarkhera 7. Ratona	
	1. Jorhat 2. Habiganj	1. Karimganj 2. Titabor 3. Jorhat	**ASSAM** *Agricultural Department*		1. Khanapara 2. Sylhet 3. Upper Shillong	1. Jorhat
1. Peshawar		1. Tarnab 2. Naurang Serai	**NORTH-WEST FRONTIER PROVINCE** *Agricultural Department* 1. Haripur 2. Parachinar 3. Derah Ismail Khan			

Key to the Diagrammatic Map of Agricultural Stations—contd.

Research Institutes, Agricultural and Veterinary Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			ORISSA			
			Agricultural Department			
1. Cuttack	1. Cuttack Rice Research Station (Berhampore)*	1. Cuttack	1. Sambalpur 2. Angul 3. Balia 4. Kujang 5. Khurdah 6. Puri		1. Cuttack	
			SIND			
			Agricultural Department			
1. Sakrand 2. Dokri]	1. Larkana 2. Mirpurkhas 3. Shikarpur	1. Mirpurkhas	1. Dadu 2. Oderolal 3. Lundo 4. Padidam 5. Nasirabad 6. Shahdadkote	1. Mirpurkhas		
			BALUCHISTAN			
	1. Quetta (Fruit Experimental Station)		*Agricultural Department*	1. Usta		

			HYDERABAD STATE			
			Agricultural Department			
1. Himayatsagar, Hyderabad (Deccan)	1. Parbhani 2. Raichur	1. Sangareddi 2. Warangal 3. Rudrur	1. Mahbubnagar		1. Himayatsagar, Hyderabad (Deccan)	
			MYSORE STATE			
			Agricultural Department			
1. Bangalore		1. Hebbal 2. Nagenhalli 3. Hunsur 4. Marthur 5. Balehonnur (Headquarters of the United Planters' Association of Southern India Coffee Scientific Officer) 6. Babbur	1. Chikkanhalli 2. Hassan 3. Ramkrishnapur 4. Singapore	1. Mysore Irwin Canal Farm (Experimental work on sugarcane, paddy and other crops is also conducted here)	1. Ajjampur (Cattle-breeding Station) 2. Yeliachihalli (Sheep farm)	
			BARODA STATE			
	1. Baroda (Cotton Root-rot Research Scheme)	1. Baroda 2. Amreli 3. Jagudan 4. Vyara (Cane-farm)				1. Makarpura

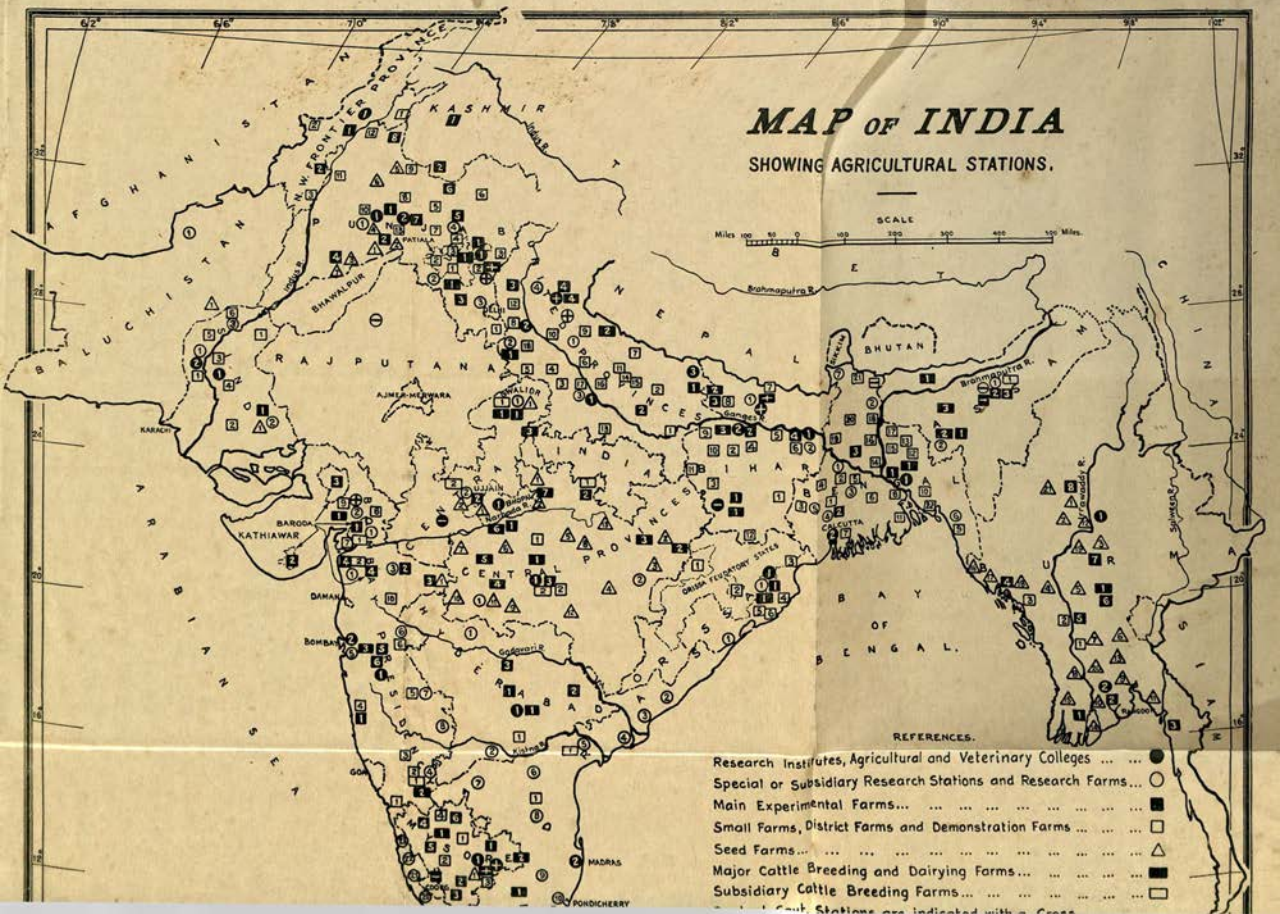
* This station (Berhampore) is situated within the new Province of Orissa, but was under the control of the Department of Agriculture, Madras, during 1935-36.

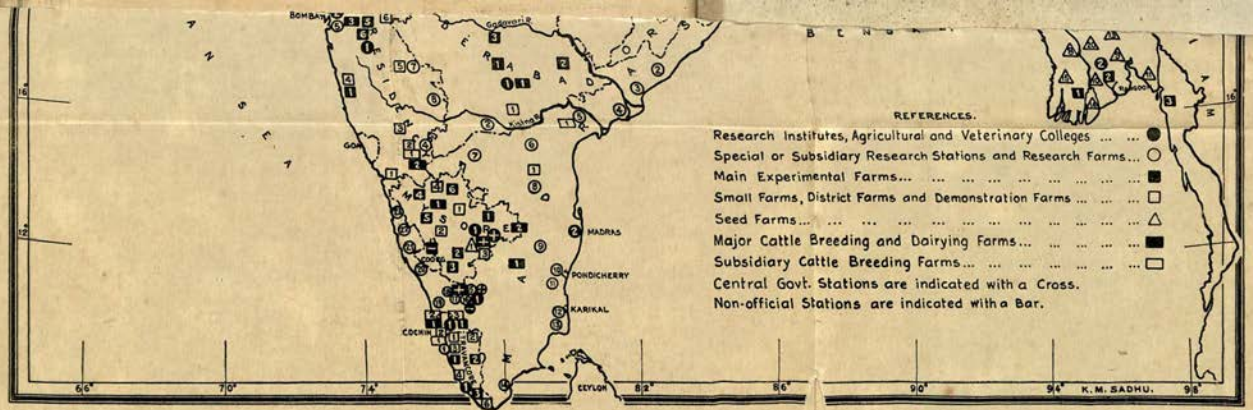
Key to the Diagrammatic Map of Agricultural Stations—concld.

Research Institutes, Agricultural and Veterinary Colleges	Special or Subsidiary Research Stations and Research Farms	Main Experimental Farms	Small Farms, District Farms and Demonstration Farms	Seed Farms	Major Cattle-breeding and Dairying Farms	Subsidiary Cattle-breeding Farms
			TRAVANCORE STATE			
1. Quilon		1. Alleppey 2. Koni 3. Nagercoil	1. Alwaye 2. Oachira 3. Vaikom 4. Kottarakara 5. Puliyara 6. Cape Comorin			
			COCHIN STATE			
1. Trichur	1. Ernaculam	1. Trichur	1. Thiruvankulam 2. Trichur		1. Trichur	1. Ernaculam (Coconut Station) 2. Wadakkancheri 3. Mulanthuruthy
			GWALIOR STATE			
	1. Gwalior 2. Ujjain	1. Gwalior 2. Ujjain		1. Gwalior 2. Ujjain	1. Maharajpur (Gwalior) 2. Ujjain	1. Maharajpur (Gwalior) 2. Ujjain

		1. Shalabagh, Srinagar (Pratap Model Farm) 2. Jammu (Golsamandar)	**KASHMIR STATE**			
1. Nabi Bagh			**BHOPAL STATE**	1. Sehore (Cane Farm) 2. Semri (Co-operative)		
1. Patiala (Bhupindra Agricultural Institute, Rauni)		1. Patiala (Bhupindra Agricultural Farm)	**PATIALA STATE** 1. Bassi 2. Mansa 3. Dhuri		1. Patiala (Bhupindra Dairy Farm)	
1. Indore (Central India, Institute of Plant Industry). 2. Ranchi (Bihar and Orissa Lac Research Institute). 3. Tocklai (Assam, Indian Tea Association). 4. Nellacotta (Nilgiris, U. P. A. S. I.).	Sri Ganganandapur, Bikaner State, Rajputana.	Sidapur (Madras, U. P. A. S. I.). Borbhetta (Assam, Indian Tea Association).	**NON-OFFICIAL** Tulsipara, Dooars			

MGIPC—M—III-1-34—6-11-37—800.


MAP OF INDIA
SHOWING AGRICULTURAL STATIONS.
SCALE
Miles 100 50 0 100 200 300 400 500 Miles.
REFERENCES.
Research Institutes, Agricultural and Veterinary Colleges ... ...
Special or Subsidiary Research Stations and Research Farms...
Main Experimental Farms... ... ...
Small Farms, District Farms and Demonstration Farms ... ...
Seed Farms... ... ...
Major Cattle Breeding and Dairying Farms... ... ...
Subsidiary Cattle Breeding Farms... ... ...
AFGHANISTAN
BALUCHISTAN
N.W. FRONTIER PROVINCE
KASHMIR
PUNJAB
RAJPUTANA
NEPAL
BHUTAN
ASSAM
CHINA
BENGAL PROVINCES
BIHAR
UNITED PROVINCES
CENTRAL PROVINCES
BERAR
ORISSA
BOMBAY PRESIDENCY
MADRAS
PONDICHERRY
GOA
KARACHI
BARODA
KATHIAWAR
DAMAN
BOMBAY
CALCUTTA
ORISSA FEUDATORY STATES
BAY OF BENGAL.
ARABIAN SEA
Brahmaputra R.
Ganges R.
Godavari R.
Irrawaddy R.
Salween R.
Indus R.
Sutlej R.
Jumna R.
Chambal R.
Tapti R.
Narbada R.
Mahanadi R.
Krishna R.
Pennar R.
Cauvery R.
Rangoon



Key to this map is given in Appendix XV.


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